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SOUTHERN COMPANY

March 6, 2014

Docket No.: 50-366

NL-14-0231

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555-0001

Edwin I. Hatch Nuclear Plant – Unit 2
Proposed Inservice Inspection Alternative HNP-ISI-ALT-HDPE-01, Version 1.0

Ladies and Gentlemen:

Pursuant to 10 CFR 50.55a(a)(3)(i), Southern Nuclear Operating Company (SNC) hereby requests NRC approval of the proposed HNP-ISI-ALT-HDPE-01, Version 1.0, regarding paragraph IWA-4221(b) of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI.

This ISI Alternative (provided in Enclosure 1) is needed to support planned replacement of buried steel piping in Hatch Unit 2, Plant Service Water (PSW) system with high density polyethylene (HDPE) piping. See Enclosure 3 for a sketch of proposed HDPE piping tie-ins and conceptual routing. For this repair/replacement activity, IWA-4221(b) would require the new/replacement piping to meet the original Construction Code requirements for the PSW piping. The applicable Construction Code does not provide rules for the design, fabrication, installation, examination and testing of HDPE piping.

A draft ASME Section III Appendix (intended to replace Code Case N-755-2), along with draft Section XI Code Case N-808, provide the most up-to-date requirements and conditions under which HDPE material may be used for ASME Section III, Class 3 buried piping systems. Since the ASME documents are currently in the approval process, the requirements hereinafter will be referred to as Alternative Technical Requirements (ATR) (Enclosure 2). The content of the ATR is taken directly from the two referenced in-process ASME documents, excluding provisions that are not applicable to the intended scope of work. Although somewhat enhanced and more restrictive, the ATR is consistent with Code Case N-755, which was the basis for the Callaway Relief Request for the use of HDPE. SNC has chosen to simulate the testing and examination methodology applied to the Callaway project as approved by the NRC.

In a public meeting on January 7, 2014, the NRC provided to the industry their expectations for future ISI Alternatives seeking approval to design and install buried HDPE piping. Those expectations are summarized in ADAMS Document No. ML13318A046, which was discussed during the January 7th meeting. All NRC expectations have been addressed in the enclosed ATR, as described in Enclosure 4.

A047
NRR

To ensure the highest confidence in the quality, consistency and slow crack growth resistance of the resin to be used for this Alternative Request, SNC has chosen Dow Chemical, DGDA-2492 resin to be used for all pipe and fittings. The technical information for Dow Chemical resin DGDA-2492 is provided in Enclosure 5.

Replacement of the current PSW steel piping with HDPE piping will provide an overall benefit to plant safety since HDPE piping is much more resistant to fouling and microbiologically induced corrosion, thus assuring improved long-term reliability of the risk-significant PSW system. The HDPE Piping will be connected to the existing system through flanged stainless steel piping, which provides improved corrosion resistance over carbon steel.

To provide sufficient time for planning of the PSW piping replacement and to provide assurance of the planned approach, SNC respectfully requests NRC review and approval of the attached ISI Alternative by December 18, 2014. Once NRC approval is granted, it will take approximately 1.25 years for the HDPE piping to be delivered on site, using the quality assurance steps outlined in Enclosure 2. Once on site, it will take slightly under one year to excavate and install the piping. The project goal is to place the new HDPE piping in service following the spring 2017 Hatch Unit 2 refueling outage.

Hatch Unit 2 is presently in the fourth ISI interval which ends on December 31, 2015. Based on the discussion above related to schedule, this replacement will be performed in both the fourth and fifth ISI intervals. It is our understanding that proposed rulemaking to incorporate a later edition of ASME Sections III and XI per 10 CFR 50.55a is being developed, but it is not scheduled to be issued until approximately September 1, 2014. Therefore, Hatch will be using the 2007 Edition with the 2008 Addenda for the fifth ISI interval unless the site decides to voluntarily update to a later version. At this time, SNC is expecting to implement the 2007 Edition with the 2008 Addenda for the fifth ISI interval. The enclosed ISI alternative calls out the applicable Section XI editions for both ISI intervals to address the time-frame for this implementation.

This letter contains no NRC commitments. If you have any questions, please contact Ken McElroy at (205) 992-7369.

Respectfully submitted,

C. R. Pierce
Regulatory Affairs Director

CRP/RMJ/lac

Enclosures: 1. Proposed Alternative HNP-ISI-ALT-HDPE-01, Version 1.0 to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

2. Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

3. Sketch of Proposed HDPE Piping Tie-ins and Conceptual Routing

4. Summary of the Plant Hatch HDPE ISI Alternative with the NRC Expectations described in ADAMS Document No. ML13318A046

5. Technical Information for Dow Chemical resin, DGDA-2492

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Edwin I. Hatch Nuclear Plant – Unit 2
Proposed Inservice Inspection Alternative HNP-ISI-ALT-HDPE-01, Version 1.0

Enclosure 1

Proposed Alternative HNP-ISI-ALT-HDPE-01, Version 1.0 to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Proposed Alternative HNP-ISI-ALT-HDPE-01, Version 1.0 to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Plant Site-Unit:	Edwin I. Hatch Nuclear Plant (HNP) - Unit 2.
Interval Dates:	Fourth Inservice Inspection (ISI) Interval – January 1, 2006 through December 31, 2015. Fifth ISI Interval – January 1, 2016 through December 31, 2025.
Requested Date for Approval :	Approval is requested by December 18, 2014.
ASME Code Components Affected:	The affected piping consists of Division II Plant Service Water (PSW) from the Turbine Building isolation valve box to the Reactor Building. This is Class 3 10-inch diameter piping which is buried and unlined. The function of this piping is to supply PSW to the drywell and the reactor building coolers. Both Unit-1 and -2 PSW buried piping were installed at the same time with the design and installation being performed per B31.7 – USAS Code for Pressure Piping.
Applicable Code Edition and Addenda:	The applicable Code edition and addenda (for the fourth ISI interval) is ASME Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2001 Edition through the 2003 Addenda (Reference 1). The installation process will be performed during the fifth ISI interval and as described below, will be to the 2007 Edition through the 2008 Addenda (Reference 2).
Applicable Code Requirements:	During the process of replacing this buried carbon steel piping, Article IWA-4000, subparagraph IWA-4221(b) requires that items used during a repair/replacement activity meet the construction code.
Reason for Request:	Southern Nuclear Operating Company (SNC) has decided to replace the buried carbon steel piping described above with high density polyethylene (HDPE) piping. Article IWA-4000, subparagraph IWA-4221(b) requires that items and materials for any ASME repair/replacement activity need to meet the construction code. The use of HDPE piping for ASME applications is a recent technology improvement and was not available in the 1970's to meet the construction code. SNC is not able to use an edition of ASME Section XI or a Code Case accepted by the NRC for this application. SNC is therefore submitting an ISI Alternative requesting approval to implement this repair/replacement activity.
Proposed Alternative:	The proposed ISI Alternative and supporting details in the Enclosures provide the technical basis for the use of HDPE piping. These details include material procurement, design, fabrication, installation, as well as examination and testing of HDPE piping. Additional information is provided below to support the use of this piping, and the enclosures give more details related to this issue.

Proposed Alternative HNP-ISI-ALT-HDPE-01, Version 1.0 to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Basis for Use:	Four additional enclosures are attached to this ISI Alternative: 1. Enclosure 2 is the Hatch-2 Alternative Technical Requirements (ATR) which describes the technical details for the implementation process for the material procurement, design, fabrication, installation, as well as the examination and testing of HDPE piping for Division II PSW. This is based on the installation work done at the two domestic plants as well as changes made to address regulatory concerns. It is a package that has been maintained and incorporates the latest industry work related to HDPE. This package includes specific references to ASME Section XI, Article IWA-4000 which will be addressed. These references will be to ASME Section XI, 2001 Edition with 2003 Addenda for material and initial design, and to ASME Section XI, 2007 Edition through the 2008 Addenda for installation, examination and testing. Enclosure 2 includes several Supplements: Supplement 1 identifies the applicable standards that are referenced, Supplement 2 applies to the Ultrasonic Examination of High Density Polyethylene, Supplement 3 defines the requirements applicable to fusing qualifications, Supplement 4 provides the Code Data report form to document these Code activities, and Supplement 5 provides details of the pressure testing activities applicable for the duration of plant life. In addition, two Nonmandatory Supplements are included: Supplement A applies to Fusing Machine Operator Qualification Training and Supplement B provides examples of Unacceptable Fusion Bead Configurations. 2. Enclosure 3 is a sketch depicting the tie-in locations of the new HDPE piping at the existing yard valve box and at a new tie-in vault outside the Torus Area. This sketch also shows the conceptual routing of the new piping between the two vaults. 3. Enclosure 4 is a Comparison of the NRC Expectations described in ADAMS Document No. ML13318A046 and discussed at the January 7, 2014 public meeting with content of the Alternative Technical Requirements. This demonstrates that all expectations are addressed in this ISI Alternative. 4. Finally, Enclosure 5 is the technical information of Dow Chemical, DGDA-2492 resin that is planned for use at Hatch-2. Based on the detailed technical information provided with this alternative, SNC believes this alternative will provide an acceptable level of quality and safety. Therefore, it is requested that the NRC authorize this proposed alternative in accordance with 10 CFR 50.55a(a)(3)(i).

Proposed Alternative HNP-ISI-ALT-HDPE-01, Version 1.0 to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Duration of Proposed Alternative:	The implementation of HDPE piping will be performed during the fourth and fifth ISI Intervals. The use of HDPE material plus periodic pressure testing as described in this alternative provides Hatch-2 with high quality Division II Plant Service Water piping for the remaining operational life of the plant.
Precedents:	1. Safety Evaluation Report for Relief Request 13R-10, Use of Polyethylene Pipe in Lieu of Carbon Steel Pipe in Buried Essential Service Water System (TAC No. MD6792) at Callaway Plant, Unit 1, dated November 7, 2008 (ML083100288). 2. Safety Evaluation Report for Relief 06-CN-003, Use of Polyethylene Material in Buried Service Water Piping (TAC NOS. ME0234 and ME0235) at Catawba Nuclear Station, Units 1 and 2, dated May 27, 2009 (ML091240156).
References:	1. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, 2001 Edition with the 2003 Addenda. 2. ASME Boiler and Pressure Vessel Code, Section XI, 2007 Edition with the 2008 Addenda.
Status:	Awaiting NRC approval.

Edwin I. Hatch Nuclear Plant – Unit 2
Proposed Inservice Inspection Alternative HNP-ISI-ALT-HDPE-01, Version 1.0

Enclosure 2

Proposed Alternative Technical Requirements
to ASME Section XI Requirements for Replacement of Class 3 Buried Piping
in Accordance with 10 CFR 50.55a(a)(3)(i)

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Alternative Technical Requirements

Plant Hatch – Unit 2

Partial HDPE Replacement for Div II Plant Service Water Piping

Note: All paragraph, figure and table number references in this document refer to this ATR unless otherwise noted as ASME Section III, ASME Section V, ASME Section XI, etc.

1000 GENERAL REQUIREMENTS

1100 SCOPE

These Alternative Technical Requirements (ATR) apply to Plant Hatch Division II Plant Service Water (PSW) supply piping from the Turbine Building isolation valve box to the Reactor Building. This ATR is proposed as an ISI alternative to the Construction Code and ASME Section XI requirements under Alternative HNP-ISI-ALT-HDPE-01.

(a) These Requirements address replacement of the existing buried and unlined carbon steel Class 3 NPS 10 piping with IPS[1] 12 HDPE piping produced with PE4710 material of cell classification 445574C. Design conditions are as follows:

Condition	Temperature, °F	Pressure, psig
Normal operating	95	140
Maximum Operating	95	190
Design	125	180

(b) Except as otherwise stated, the provisions of this ATR shall apply in lieu of IWA-4000, ASME Section XI, 2001 Edition through 2003 Addenda, and ASME Section XI, 2007 Edition through 2008 Addenda.

(1) The requirements of IWA-4140 through IWA-4170, and IWA-4300 shall apply.

(2) The requirements of 6000 shall be used in lieu of IWA-4500.

(3) Use of this ATR shall be identified on the NIS-2 report form.

All modifications to existing metallic materials or components that interface with polyethylene material shall meet the requirements of the original Construction Code.

1200 RESPONSIBILITIES

(a) The Owner, Southern Nuclear Operating Company (SNC), shall perform all of the functions required by this ATR that are not performed by the Polyethylene Material Organization. SNC may elect to perform any other Quality Program functions that would normally be the responsibility of the Polyethylene Material Organization. Such functions performed by SNC shall be described in the Plant Hatch Repair/ Replacement Program.

[1] NPS is the common term used for steel piping, IPS is the common term used for plastic piping; both are dimensionally equivalent.

(b) SNC shall make all necessary provisions for the Authorized Inspection Agency to perform the inspections necessary to comply with this ATR. All references herein to "Inspector" shall apply to the Authorized Nuclear Inservice Inspector.

(c) SNC shall be responsible for surveying, qualifying, and auditing the Polyethylene Material Organization, to verify that the organization's Quality Assurance Program conforms with this ATR and to the Plant Hatch Quality Assurance Program requirements.

(d) Satisfactory completion of the survey and audit will allow the Polyethylene Material Organization to supply material to Plant Hatch for a period of three years. After the three-year period, a triennial audit shall be performed, if necessary for continued supply of material.

(e) Should SNC elect to use an ASME HDPE Certificate Holder to perform material supply or fabrication, SNC shall audit the Certificate Holder as a Repair/Replacement Organization in compliance with 10CFR50 Appendix B, the Plant Hatch Quality Assurance Program, and the Plant Hatch Section XI Repair/Replacement Program. The Certificate Holder will then be responsible for (a) through (d) as delineated in the Plant Hatch Repair/ Replacement Program.

(f) SNC shall be responsible for design of the HDPE piping in accordance with this ATR.

(g) SNC shall be responsible for fabrication, fusing, installation, inspection and testing of the HDPE piping in accordance with this ATR and applicable design requirements.

2000 MATERIAL

All HDPE material shall, to the extent practical, be produced from a single batch of Dow Chemical, DGDA-2492 resin meeting the requirements stipulated herein. HDPE piping items shall include only 12 DR7 [2, 3] straight pipe, fabricated mitered elbows with segments one DR larger than the connecting pipe, and 12 inch flange adaptors rated for the design conditions. All HDPE-to-HDPE connections will be made using the butt thermal fusion process.

2200 POLYETHYLENE MATERIAL REQUIREMENTS

(a) Natural compound, pigment concentrate compound, polyethylene compound and polyethylene material shall conform to the requirements this ATR.
(b) Conformance with ASTM Standards referenced in Supplement 1 and herein shall be limited as specified in this ATR. In the event of conflict between a referenced standard and this ATR, the requirements of this ATR shall take precedence.
(c) Natural compound, pigment concentrate compound, polyethylene compound, and polyethylene material shall be marked in accordance with the marking requirements in 8000 and the applicable ASTM standard.

[2] DR = Dimension Ratio = (Outside Diameter)/(thickness)
[3] This DR presumes design conditions of 125°F and 180 psig.

2220 SPECIFIC COMPOUND REQUIREMENTS

2221 Requirements for Certification of Polyethylene Compound

(a) General

(1) Polyethylene Compound shall comply with and be certified in accordance with this ATR and Table 2221-1.

(2) The required value for each property shall be as specified in Table 2221-1.

(3) The standard for determining the required value for properties shall be as specified in Table 2221-1.

(4) The test method for determination of the required value for the physical property shall be as specified in Table 2221-1.

(b) Polyethylene compound used for the manufacture of polyethylene material shall meet the requirements of the polyethylene compound manufacturer and Table 2221-1.

(c) Polyethylene compound shall be black except as provided in 2231(b).

(d) Polyethylene compound is the combination of natural compound and pigment concentrate compound as follows:

(1) When polyethylene compound is combined by the Polyethylene Compound Manufacturer, polyethylene compound is the polyethylene source material.

(2) When polyethylene compound is combined by the Polyethylene Material Manufacturer, natural compound and pigment concentrate compound are the polyethylene source materials.

(3) When polyethylene compound is combined by the Polyethylene Material Manufacturer, the Natural Compound Manufacturer shall provide the Polyethylene Material Manufacturer with a formulation that specifies the weight ratio (proportions) of natural compound and pigment concentrate compound, and with processing equipment setting recommendations that produce polyethylene compound in accordance with Table 2221-1.

(e) Polyethylene compound shall exceed 2000 hr Pennsylvania Edge-Notch Tensile Test (PENT) per ASTM F1473[4] and shall have an independent listing that is published in PPI TR-4, Table I.A.13. The independent listing shall identify the following:

(1) A standard grade hydrostatic design basis (HDB) rating of at least 1,600 psi (11.03 MPa) at 73°F.

(2) A standard grade HDB rating of at least 1,000 psi MPa) at 140°F.

(3) A hydrostatic design stress (HDS) rating of at least 1,000 psi for water at 73°F.

(4) Standard grade HDB ratings and HDS ratings shall be determined in accordance with PPI TR-3, Parts A, D, and F.

(5) The polyethylene compound shall have a material designation of PE4710 in accordance with PPI TR-4, Table-I.A.13.

(6) The unique trade name or designation for the polyethylene compound.

(7) The Polyethylene Natural Compound Manufacturer.

(f) The Polyethylene Material Manufacturer of polyethylene pipe shall have a dependent listing for black polyethylene compound that is published in PPI TR-4, Table I.A.13. The black polyethylene compound shall exceed 2000 hr Pennsylvania Edge-Notch Tensile Test (PENT) per ASTM F1473 and the dependent listing shall identify the following:

[4] Dow Chemical, DGDA-2492 resin has a PENT value >10,000 hr (see Enclosure 5)

(1) A standard grade hydrostatic design basis (HDB) rating of at least 1,600 psi at 73°F.

(2) A standard grade HDB rating of at least 1,000 psi at 140°F.

(3) A hydrostatic design stress (HDS) rating of at least 1,000 psi for water at 73°F.

(4) Standard grade HDB and HDS ratings in accordance with PPI TR-3, Parts A, D and F.

(5) A unique trade name or designation to the polyethylene compound that is published in PPI TR-4, Table I.A.13.

(g) The Certificate of Analysis (C of A) shall identify the trade name or designation assigned to the polyethylene compound by the Polyethylene Compound Manufacturer that is published in PPI TR-4.

(h) The Certified Polyethylene Test Report (CPTR) shall identify the trade name for the polyethylene compound assigned by the Polyethylene Material Manufacturer that is published in PPI TR-4, Table I.A.13, and shall identify the following:

(1) The C of A trade names for the natural compound and the pigment concentrate compound, or

(2) The C of A trade name for the polyethylene compound

(i) Color polyethylene compound shall contain color and ultraviolet (UV) stabilization in accordance with ASTM D3350 Code E. Color polyethylene compound shall be used for green color stripes on safety related polyethylene, to differentiate it from non-safety material.

2222 Natural Compound

(a) Natural compound shall meet requirements specified by the Natural Compound Manufacturer.

(b) Natural compound shall be combined with pigment concentrate compound in accordance with 2221(d).

(c) The Natural Compound Manufacturer shall assign a unique trade name or designation to the natural compound.

2223 Pigment Concentrate Compound

(a) Black pigment concentrate compound shall meet requirements specified by the Natural Compound Manufacturer.

(b) Black pigment concentrate compound shall be combined with natural compound in accordance 2221(d)(3).

(c) The Pigment Concentrate Compound Manufacturer shall assign a unique trade name or designation to the pigment concentrate compound.

(d) Color pigment concentrate compound shall be in accordance with 2231(b)

2230 SPECIFIC MATERIAL REQUIREMENTS

(a) This section identifies the specific requirements applicable to the various product forms permitted by this ATR.

(b) All fabrications produced by fusing shall be produced by SNC or by a Certificate Holder audited and approved by SNC in accordance with 1200. Only fusing procedures and fusing machine operators trained and qualified in accordance with this ATR shall be used.

(c) All fused joints shall be examined in accordance with Article 5000.

2231 Polyethylene Material — Pipe

(a) Polyethylene pipe shall be manufactured in accordance with this ATR and ASTM F714. Elevated temperature sustained pressure test per ASTM F714 shall be successfully completed at least once for pipe supplied in accordance with this ATR, and every six months thereafter, if applicable.

(b) Pipe shall be black and shall be manufactured by extrusion. With the exception of color stripes per this section, black pipe shall contain 2% to 3% carbon black that is well dispersed through the pipe wall when samples taken from pipe are tested per ASTM D1603 or ASTM D4218.

(1) A single green color stripe shall be coextruded into the pipe outside surface. The depth of the color stripe into the pipe outside surface shall not exceed 10% of the $t_{fab\ min}$ wall thickness. The color stripe shall not project above the pipe outside surface and shall not be covered in whole or in part by black pipe material.

(2) Where natural compound and pigment concentrate compound are combined by the Polyethylene Material Manufacturer, the Polyethylene Material Manufacturer shall use the same natural compound with black pigment concentrate compound and with color pigment concentrate compound if optional color stripes are coextruded into the pipe outside surface.

(3) Where black polyethylene compound and color polyethylene compound are used to extrude pipe with optional color stripes, coextruded into the outside surface, the black polyethylene compound and color polyethylene compound shall use the same natural compound.

(c) Pipe print line marking shall be applied during extrusion using heated indentation.

(d) Prior to shipment of the pipe, testing for fusibility of the material shall be performed in accordance with 2300, unless otherwise specified by SNC or its designee.

2232 Polyethylene Material — Flange Adapter

(a) Flange adapters shall only be fabricated from pipe or the molding process using polyethylene materials meeting the requirements of 2200.

(b) The configuration shall be in accordance with 4720.

(c) The pressure rating, PR, shall be determined in accordance with 3132.

(d) The pressure rating shall be confirmed by testing in accordance with ASTM D3261 or ASTM F2206.

(e) Prior to shipment of flange adaptors, testing for fusibility of the material shall be performed in accordance with 2300 of this Article, unless otherwise specified by SNC or its designee.

(f) Flange adapters shall be machined from polyethylene pipe meeting the requirements of 2231.

2233 Polyethylene Material – Mitered Elbows

(a) The polyethylene material used for mitered elbows shall be pipe meeting the requirements of 2231.

(b) The configuration of the mitered elbow shall meet the dimensional requirements of the specifications listed in Supplement 1, and the additional requirements of 3132.1.

(c) Prior to shipment of mitered elbows, testing for fusibility of the material shall be performed in accordance with 2300, unless otherwise specified by SNC or its designee.

(d) The Data Report Form NM(PE)-1 (Supplement 4) shall be used for this product form.

2300 POLYETHYLENE MATERIAL FUSING VERIFICATION TESTING

2310 GENERAL

(a) All polyethylene material product forms shall be tested for compliance with the Plant Hatch Fusing Procedure Specification (FPS) described in Supplement 3, QF-220, unless otherwise specified.

(b) The polyethylene materials tested shall be from the same Polyethylene Material Manufacturer's manufacturing facility that supplies the polyethylene materials to be used in production.

(c) Joint fusibility testing shall include each polyethylene source material supplied by the same or different polyethylene Material Manufacturers in all combinations of suppliers and in all diameters and thicknesses to be fused in production.

(d) All joint testing shall use the same fusing machine make and carriage model to be used for joining the materials in production. See 4321(c).

(e) Joint fusibility testing shall be performed by the Polyethylene Material Manufacturer unless otherwise specified by the Owner or its designee.

(f) Fusibility testing results shall be included in the CPTR.

2320 FUSING PARAMETERS FOR TESTING

One joint shall be made at each of the following conditions:

(a) Interfacial pressure of 90 psi and heater temperature of 450°F; heater removal (dwell) time kept to a minimum (must not exceed the specified maximum).

(b) Interfacial pressure of 60 psi and heater temperature of 450°F; heater removal (dwell) time kept to a minimum (must not exceed the specified maximum).

(c) Interfacial pressure of 90 psi and heater temperature of 400°F; heater removal (dwell) time at the maximum permitted.

(d) Interfacial pressure of 60 psi and heater temperature of 400°F; heater removal (dwell) time at the maximum permitted.

2330 TESTING

Testing of the joints shall be in accordance with Supplement 3, QF-144. Not less than four specimens shall be removed from fused pipe test coupons at intervals approximately 90 deg apart.

2400 REPAIR OF MATERIAL

Repair of manufactured or fabricated polyethylene pipe and fittings shall not be permitted. Polyethylene pipe or fittings with gouges, cuts or other surface conditions greater than 0.040" or any indentation resulting in a wall thickness of less than $t_{fab\ min}$ shall be unacceptable, and shall be rejected and scrapped.

2500 GENERAL REQUIREMENTS FOR QUALITY TESTING AND DOCUMENTATION

(a) The Polyethylene Source Material Manufacturer shall ensure that polyethylene compound is certified[7] in accordance with 2221.

(b) Acceptance of individual lots of polyethylene source material shall be in accordance with 2501.

2501 Certificate of Analysis (C of A)

The following subparagraphs contain requirements for C of A and related traceability documentation.

2501.1 Polyethylene Compound.

(a) Polyethylene compound shall be qualified per 2221.

(b) The Polyethylene Compound Manufacturer shall test polyethylene compound in accordance with Table 2501.1 and shall provide a C of A and related traceability documentation to the purchaser of the lot.

(c) The C of A Report shall include the certified test results in accordance with Table 2501.1

(d) The C of A Report and related traceability documentation shall include the following information:

(1) the name of the Polyethylene Compound Manufacturer,

(2) the manufacturing location,

(3) an identification code that is unique and traceable to the specific lot,

(4) the Polyethylene Compound Manufacturer's trade name for the polyethylene compound as published in PPI TR-4,

(5) the shipping method or type of container(s) for the lot such as railcar or boxes and additional information such as a railcar number if shipped by rail or the name of the commercial carrier and number of boxes if shipped by commercial carrier,

(6) the lot weight of polyethylene compound,

(7) the date of shipment,

(8) other information that identifies the purchaser (customer), purchaser order, purchaser contact, purchaser delivery location, and contact information for the Polyethylene Compound Manufacturer,

(9) if applicable, the Quality System Program statement information per NCA-3974.4.

2501.2 Natural Compound

(a) The Natural Compound Manufacturer shall test natural compound in accordance with Table 2501.2. The Natural Compound Manufacturer shall provide a C of A and related traceability documentation to the purchaser of the lot.

(b) The C of A Report shall include the certified test results in accordance with Table 2501.2.

(c) The C of A Report and related traceability documentation shall include the following information:

(1) the name of the Natural Compound Manufacturer,

(2) the manufacturing location,

(3) an identification code that is unique and traceable to the specific lot,

(4) the Natural Compound Manufacturer's trade name for the natural compound,

(5) the shipping method or type of container(s) for the lot such as railcar or boxes and additional information such as a railcar number if shipped by rail or the name of the commercial carrier and number of boxes if shipped by commercial carrier,

(6) the lot weight of natural compound,

(7) the date of shipment,

(8) other information that identifies the purchaser (customer), purchaser order, purchaser contact, delivery location, and contact information for the Natural Compound Manufacturer,

(9) if applicable, the Quality System Program statement information per NCA-3974.4.

2501.3 Pigment Concentrate Compound

(a) The Pigment Concentrate Compound Manufacturer shall test pigment concentrate compound in accordance with Table 2501.3. The Pigment Concentrate Compound Manufacturer shall provide a C of A Report and related traceability documentation to the purchaser of the lot.

(b) The C of A Report shall provide the certified test results for the lot in accordance with Table 2501.3.

(c) The C of A Report or related traceability documentation shall include the following information:

(1) the name of the Pigment Concentrate Compound Manufacturer,

(2) the manufacturing location,

(3) an identification code that is unique and traceable to the specific lot,

(4) the Pigment Concentrate Compound Manufacturer's trade name for the pigment concentrate compound,

(5) the shipping method or type of container(s) for the lot such as railcar or boxes and additional information such as a railcar number if shipped by rail or the name of the commercial carrier and number of boxes if shipped by commercial carrier,

(6) the lot weight of pigment concentrate compound,

(7) the date of shipment,

(8) other information that identifies the purchaser (customer), purchaser order, purchaser contact, delivery location, and contact information for the Pigment Concentrate Compound Manufacturer,

(9) if applicable, the Quality System Program statement information per NCA-3974.4.

2502 Certified Polyethylene Test Report for Polyethylene Material— Pipe

(a) The Polyethylene Material Manufacturer — Pipe:

(1) shall certify the Certificate of Analysis report values by testing a sample from the polyethylene source material lot in accordance with Table 2502(a),

(2) shall not use the material when certification testing does not verify C of A Report values,

(3) shall test pipe in accordance with Table 2502(b) and shall provide a CPTR to the purchaser.

(b) The CPTR shall include the following per lot:

(1) certified test results for the lot in accordance with Tables 2502(a) and (b),

(2) the name of the Polyethylene Material Manufacturer,

(3) the manufacturing location,

(4) an identification code that is unique and traceable to the specific lot,

(5) the ASTM standard for pipe manufacture,

(6) the specification for the polyethylene compound,

(7) the shipping method and the name of the commercial carrier,

(8) the lot length,

(9) the date of shipment,

(10) other information that identifies the purchaser (customer), purchaser order, purchaser contact, delivery location, and contact information for the Polyethylene Material Manufacturer,

(11) a certification that the polyethylene material was made from only virgin polyethylene source material, and that no scrap or regrind polyethylene material was used (see NCA-3974.3),

(12) certification of slow crack growth resistance (greater than 2000 hr PENT per ASTM F1473 completed on a compression molded plaque at 2.4 MPa and 80°C per Table 2221-1 for the polyethylene compound),

(13) results of fusibility testing performed in accordance with 2300,

(14) the Quality System Program statement information per NCA-3974.4.

Table 2221-1
Certification Requirements for Polyethylene Compound

No.	Property, Units	Required Value	Requirement Standard	Test Method
1	Density, g/cm^3	(a) 0.956 to 0.968 w/2 to 3% carbon black (b) 0.947 to 0.955 w/o carbon black or pigment	ASTM D3350	ASTM D1505 or ASTM D792 or ASTM D4883
2	High load melt flow rate, g/10 min.	4 to 20	Polyethylene Compound Manufacturer Quality Program	ASTM D1238, Condition 190/21.6
3	Carbon black, %	2 to 3	ASTM D3350 and Table 2221-1	ASTM D4218 or ASTM D1603
4	Slow Crack Growth resistance (parent material), hr	>2,000	ASTM D3350	ASTM F1473 at 2.4 MPa and 80°C in air
5	Thermal Stability, °F (°C)	>428 (>220)	ASTM D3350	ASTM D3350
6	Tensile strength at yield, psi (MPa)	≥3500 (≥24.24)	ASTM D3350	ASTM D638, Type IV at 50 mm/min. (2 in./min.)
7	Tensile elongation at break, %	≥500	ASTM D3350	ASTM D638, Type IV at 50 mm/min. (2 in./min.)
8	HDB at 73°F (23°C), psi (MPa)	1,600 (11.03)	ASTM D2837, PPI TR-3 and PPI TR-4	ASTM D2837, PPI TR-3 and PPI TR-4
9	HDB at 140°F (60°C), psi (MPa)	1,000 (6.90)	ASTM D2837, PPI TR-3 and PPI TR-4	ASTM D2837, PPI TR-3 and PPI TR-4
10	HDS for water at 73°F (23°C), psi (MPa)	1,000 (6.90)	ASTM D2837, PPI TR-3 and PPI TR-4	ASTM D2837, PPI TR-3 and PPI TR-4
11	Thermoplastic pipe materials designation code	PE4710	Listed in PPI TR-4	NA

General Note: Only SI units are provided in Tables 2221-1, 2501.1, 2501.2, and 2501.3, since the applicable ASTM Standards do not provide U.S. Customary units.

Table 2501.1
Minimum Quality Testing Requirements for Polyethylene Compound Lots

No.	Test	Test Standard	Test Frequency	Test Timing	C of A reports test results
1	High load melt flow rate, Condition 190/21.6, g/10 min.	ASTM D1238 and Table 2221-1	Once per lot	NA	Yes
2	Density	ASTM D792 or ASTM D1505 or ASTM D4883 and Table 2221-1	Once per lot	Before lot shipment	Yes
3	Tensile strength at yield and tensile elongation	ASTM D638 and Table 2221-1	Once per lot	Before lot shipment	Yes
4	Thermal stability	ASTM D3350 and Table 2221-1	Once per lot	Before lot shipment	Yes
5	Carbon black content	ASTM D1603 or ASTM D4218 and Table 2221-1	Once per lot	Before lot shipment	Yes

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Table 2501.2
Minimum Quality Testing Requirements for Natural Compound Lots

No.	Test	Test Standard	Test Frequency	Test Timing	C of A reports test results
1	High load melt flow rate, Condition 190/21.6, g/10 min.	ASTM D1238	Once per lot	NA	Yes
2	Density	ASTM D792 or ASTM D1505 or ASTM D4883, and Table 2221-1	Once per lot	Before shipment	Yes
3	Tensile strength at yield and tensile elongation	ASTM D638	Once per lot	Before shipment	Yes
4	Thermal stability	ASTM D3350	Once per lot	Before shipment	Yes

Table 2501.3
Minimum Quality Testing Requirements for Pigment Concentrate Compound Lots

No.	Test	Test Standard	Test Frequency	Test Timing	C of A reports test results
1	Carbon black content (black only)	ASTM D1603 or ASTM D4218	Every 24 hr during lot production	Every 24 hr after acceptable product has been produced for given production lot	Yes
2	Color and UV stabilizer (color only)	ASTM D3350	Every 24 hr during lot production	Every 24 hr after acceptable product has been produced for given production lot	Yes

Table 2502(a)
Minimum Quality Testing Requirements for Polyethylene Source Material

No.	Test	Test Standard	Test Frequency	CPTR reports test results
1	High load melt flow rate, Condition 190/21.6, g/10 min.	ASTM D1238	Once per lot upon receipt at the processing facility	Yes
2	Density	ASTM D792 or ASTM D1505 and Table 2221-1	Once per lot upon receipt at the processing facility	Yes
3	Carbon black concentration percentage for black polyethylene compound or black pigment concentrate compound	ASTM D1603 or ASTM D4218	Once per lot upon receipt at the processing facility	Yes
4	Slow Crack Growth resistance, hr [Note(1)]	Greater than 2,000 hr per ASTM F1473 completed on a compression molded plaque at 2.4 MPa and 80°C in Table 2221-1	Once per lot prior to shipment of polyethylene material	Yes
5	Thermal stability [Note (1)]	Greater than 428°F (220°C) ASTM D3350 and Table 2221-1	Once per lot prior to shipment of polyethylene material	Yes

Note:
(1) In no case shall any individual test result, used to establish this value in accordance with the reference industry standard, be less than the minimum required value listed in this table.

Table 2502(b)
Minimum Quality Testing Requirements for Polyethylene Material - Pipe

No.	Test/Requirement	Manufacturing Standard/ Acceptance Criteria	Test Method	Test Frequency	CPTR reports test results
1	Workmanship	<3 in. IPS (DN 80) – ASTM D3035 ≥3 in. IPS (DN 80) – ASTM F714	NA	Hourly or once per length, whichever is less frequent during ongoing production	Yes
2	Outside diameter	<3 in. IPS (DN 80) – ASTM D3035 ≥3 in. IPS (DN 80) – ASTM F714	ASTM D2122 [Note (1)]	Hourly or once per length, whichever is less frequent during ongoing production	Yes
3	Toe-in	<3 in. IPS (DN 80) – ASTM D3035 ≥3 in. IPS (DN 80) – ASTM F714	ASTM D2122 [Note (1)]	Once per shift during ongoing production	Yes
4	Wall thickness	<3 in. IPS (DN 80) – ASTM D3035 ≥3 in. IPS (DN 80) – ASTM F714	ASTM D2122 [Note (1)]	Hourly or once per length, whichever is less frequent during ongoing production	Yes
5	Short term strength	<3 in. IPS (DN 80) – ASTM D3035 ≥3 in. IPS (DN 80) – ASTM F714	ASTM D1599 or ASTM D2290	At the beginning of production and weekly thereafter during ongoing production	Yes
6	Carbon black content	Para. 2231(b)	ASTM D1603 or ASTM D4218	At the beginning of production and weekly thereafter during ongoing production	Yes

Note:
(1) Sample conditioning shall be as specified in ASTM D3035 or ASTM F714 as applicable.

3000 DESIGN

3100 SCOPE

The design rules of this section are limited to buried, polyethylene piping systems constructed of straight pipe, mitered elbows, butt and mitered fusion joints, and metal to polyethylene flanged connections.

3110 NOMENCLATURE

A = cross-sectional area of pipe at the pipe section where the evaluation is conducted, in.^{2} (mm^2)
A_s = shear area of thrust collar at the section where the evaluation is conducted, in.^{2} (mm^2)
a = difference in thickness between pipe walls at a tapered transition joint, in.
B_d= trench width, ft.
B_1 = stress index, Table 3311-1
B_2= stress index, Table 3311-1
B'= burial factor
b = total length of taper at a tapered transition joint, in.
c = the sum of mechanical allowances, installation allowance, erosion allowance and other degradation allowance, in.
c' = length of counter bore at a tapered transition joint, in.
D = average outside diameter of pipe in accordance with ASTM F714 or ASTM D3035, in.

DR = dimension ratio of pipe = average outside diameter of the pipe divided by the minimum fabricated wall thickness = $D/t_{fab\ min}$

E_{pipe} = modulus of elasticity of pipe per Table 3210-3, psi

E' = modulus of soil reaction, psi (data is site specific)

E'_N = modulus of soil reaction of native soil around trench, psi (data is site specific)

F_a = axial force due to the specified Design, Service Level A, B, C, or D applied mechanical loads, lb (N)

F_{aC} = axial force range due thermal expansion and/or contraction and/or the restraint of free end displacement, lb

F_{aD} = axial force due to the non-repeated anchor motion, lb

F_{aE}= axial force range due to the combined effects of seismic wave passage, seismic soil movement, and building seismic anchor motion effects, lb

F_{Alt}= equivalent maximum axial force range due to thermal expansion and contraction and/or the restraint of free end displacement, lb.

F_C= axial force due to fully constrained thermal contraction, lb .

F_E= axial force due to fully constrained thermal expansion, lb .

F_S= soil support factor, per Table 3210-2

f_o = ovality correction factor, per Table 3221.2-1

GSR = Geometric Shape Rating

g= acceleration due to gravity, ft/s^2

h_{hub} = thickness of thrust collar hub, in.

H= height of ground cover, ft

H_{gw}= height of ground water above top of the pipe, ft.

i= stress intensification factor, per Table 3311-1

K = bedding factor

K' = Design and Service Level longitudinal stress factor from Table 3223-1

L= deflection lag factor

M= resultant bending moment due to the specified design, Service Level A, B, C, or D applied mechanical loads, in.-lb

M_C = resultant moment range due thermal expansion and/or contraction and/or the restraint of free end displacement, in.-lb

M_D= resultant moment due to the non-repeated anchor motion, in.-lb

M_E= resultant moment range due to the combined effects of seismic wave passage, seismic soil movement, and building seismic anchor motion effects, in.-lb

N = number of equivalent full range temperature cycles

P = internal design gage pressure, plus pressure spikes due to transient events, psig

P_a= Design or Service Level A, B, C, or D pressure, psig

P_D= piping system internal Design Pressure at the specified Design Temperature T_D, both being specified in the piping Design Specification, not including the consideration of pressure spikes due to transients, psig

P_E= vertical soil pressure due to earth loads, lb/ft^2

P_{gw}= pressure due to ground water above the top of the pipe, lb/ft^2

P_{hydro}= external hydrostatic pressure, equal to earth plus groundwater pressure plus surcharge load, psi

P_L= vertical soil pressure due to surcharge loads, lb/ft^2

P_m = mitered elbow pressure rating, psig

PR = flange adapter pressure rating, psig
R = buoyancy reduction factor
r_1'= radius of curvature at the beginning of a tapered transition joint, in.
r_2'= radius of curvature at the end of a tapered transition joint, in.
r_3'= radius of curvature at the thrust collar hub, in.
S = allowable stress, per Table 3131-1(a) or (b), psi
S_A = allowable secondary stress range value as defined in 3133 and given in Table 3133-1 psi
S_{comp}= allowable side wall compression stress per Table 3220, psi
T = temperature, °F
T_D= Design Temperature, °F
T_{ground}= temperature of soil around pipe, °F
T_{water}= temperature of water running through pipe, °F
t_{Design}= minimum required wall thickness, in.
$t_{fab\ min}$ = minimum fabricated wall thickness in accordance with ASTM D3035 or F714 (called minimum wall thickness in Table 9 of ASTM F714), in.
t_{min}= minimum wall thickness for pressure, in.
t' = wall thickness of thrust collar pipe section, in.
W_P= weight of empty pipe per unit length, lb/ft
W_w= weight of water displaced by pipe, per unit length, lb/ft
w = width of thrust collar hub, in.
Z= section modulus of pipe cross section at the pipe section where the moment is calculated, $in.^3$
α= coefficient of thermal expansion of pipe, 1/°F
ΔP= differential pressure due to negative internal pressure of pipe, psi
$\Delta T = T_{water} - T_{ground}$, °F
ΔT_{eq}= equivalent temperature rise, °F
$(\varepsilon_a)_{Earthquake}$ = strain in the pipe from earthquake wave computer analysis
ε_{soil}= maximum soil strain due to seismic wave passage
ν= Poisson's ratio
Ω= change in diameter as a percentage of the original diameter, commonly called the change in ring diameter
Ω_{max}= maximum allowable change in diameter as a percentage of the original diameter, commonly called the change in ring diameter, per Table 3210-1
ρ_{dry}= density of dry soil, lb/ft^3
$\rho_{saturated}$= density of saturated soil, lb/ft^3
σ_{Alt}= tensile stress range in the pipe due to the range of thermal expansion and contraction and/or the restraint of free end displacement, psi
σ_E= tensile stress in the pipe due to an earthquake, psi
σ_{sw}= circumferential compressive stress in the sidewalls of pipe, psi
σ_{rc}= tensile stress in the pipe due to fully constrained contraction, psi
σ_{re}= tensile stress in the pipe due to fully constrained expansion, psi
τ_{Alt} = shear stress range in the thrust collar due to the range of thermal expansion and contraction and/or the restraint of free end displacement, psi
τ_C = shear stress in the thrust collar due to fully constrained thermal contraction, psi
τ_E = shear stress in the thrust collar due to fully constrained thermal expansion, psi

3120 DESIGN LIFE

(a) The design life of the system shall be 50 years.

(b) The duration of load shall be specified for each load case, and the polyethylene pipe physical and mechanical properties shall be based on the duration of load.

3125 EXAMINATION & TESTING ACCESS

Accessibility to permit future inservice examination and pressure drop testing shall be provided in the design of the piping system.

3130 DESIGN AND SERVICE LOADINGS

Design loads shall be as defined in ASME Section III ND-3112.1 through ND-3112.3. Loads applied to buried polyethylene pipe shall include, as a minimum, the following:

(a) Maximum internal Design Pressure P_D, for pressure design in accordance with 3131 and 3132, and, if applicable, maximum negative internal pressure for evaluation in accordance with 3221.2.

(b) Maximum and minimum temperature T, and the number of equivalent full range temperature cycles (N) for the selection of allowable stress and design for temperature effects in accordance with 3300. The maximum Service Level A temperature shall be the Design Temperature, T_D.

(c) Vertical soil pressure P_E, due to saturated soil, buoyancy, and flotation, for the designs in accordance with 3200.

(d) Vertical pressure due to surcharge loads P_L for the design in accordance with 3200.

(e) Permanent ground movement, soil settlement, for design as nonrepeated anchor movements in accordance with 3300.

(f) Seismic wave passage and seismic soil movement, building anchor motions, and number of seismic cycles for seismic design in accordance with 3400.

(g) Ground movement caused by frost heave for design for expansion and contraction in accordance with 3311.

3131 Pressure Design of Pipe

3131.1 Minimum Required Wall Thickness. The minimum required wall thickness of straight sections of pipe for pressure design shall be determined by the following:

$$t_{design} = t_{min} + c$$

The value of c shall include an allowance for anticipated surface damage during installation.

$$t_{min} = \frac{P_D D}{(2S + P_D)}$$

where S is from Table 3131-1(a) or (b)

The value of t_{fabmin} shall be greater than or equal to t_{design}.

3131.2 Allowable Service Level Spikes Due to Transient Pressures. The sum of the maximum anticipated operating pressure plus the maximum anticipated Level B pressure spikes due to transients shall be no greater than 1.2 times the piping system Design Pressure, P_D. The sum of the maximum

anticipated operating pressure plus the maximum anticipated Level C and D pressure spikes due to transients shall be no greater than 2 times the piping system Design Pressure, P_D.

3132 Pressure Design of Joints and Fittings

(a) Polyethylene pipe shall be joined using the butt fusion process. All connections to metallic piping shall be flanged joints.

(b) The design of piping items permitted in 2200 shall ensure these items have the capacity to withstand a pressure greater than or equal to the Design Pressure, P_D, of the attached pipe.

(c) The design of pipe fittings shall ensure the fitting has the capacity to withstand a pressure greater than or equal to the Design Pressure, P_D, of the attached pipe. The Pressure Rating (PR) of the fitting shall be determined as follows:

$$PR = GSR\ x\ \frac{2 \times S}{DR - 1} \geq P_D$$

where GSR =1.0 for flange adapters, and GSR = 0.8 for mitered elbows DR5.6 to 13.5 (with segments less than or equal to 22.5 degree directional changes per fusion).

(d) Flanged connections shall include a metallic backup ring and shall provide a leak tight joint up to and including the piping hydrostatic test pressure. In addition, the maximum surge pressure per 3131.2 shall not cause permanent deformation of the pipe.

3132.1 Pressure Design of Miter Elbows

(a) The design pressure rating of the mitered elbow, P_m, shall be calculated as the lesser of Equations (1) and (2), provided below (reference Fig. 3132-1).

$$P_m = \frac{St_{elbow}}{r_2}\left(\frac{t_{elbow}}{t_{elbow} + 0.622 \tan\theta\sqrt{t_{elbow} r_2}}\right) \quad (1)$$

$$P_m = \frac{St_{elbow}}{r_2}\left(\frac{R_1 - r_2}{R_1 - 0.5r_2}\right) \quad (2)$$

where S is from Table 3131-1(a) or (b)

(b) P_m shall be greater than or equal to P_D. Alternatively, the mitered elbow shall be at least one standard dimension ratio (SDR) lower than that of the attached straight pipe. The maximum DR permitted for mitered elbow segments is 13.5.

(c) The minimum fabricated wall thickness of the reinforced sections of the mitered elbow shall be ≥ 1.25 $t_{fab\ min}$ of the attached straight pipe. The additional wall thickness shall be provided by enlarging the

pipe OD while maintaining the pipeline ID, or, by reducing the pipe ID while maintaining the pipeline OD.

(d) The fabrication tolerance of the fitting angular direction shall be ±3 degrees. Mitered joints of 3 degrees or less (angle α_{elb} in Figure 3132-1) do not require re-design consideration as mitered elbows.

(e) Mitered elbows shall comply with the requirements of ASME Section III ND-3644 with the following exceptions: (a) wall thickness shall be determined as outlined in (c) above and ND 3644 (e) shall be replaced with butt fusion joints in accordance with this ATR.

3133 Allowable Stress Range for Secondary Stress

The allowable secondary stress range, S_A, is given in Table 3133-1.

(a) The S_A value (see Table 3133-1) shall be based on the higher of the Design Temperature or the maximum Level A or B temperature.

(b) The S_A shall be selected based on (1) the total number of temperature cycles or (2) the number of equivalent full range temperature cycles, *N*, as determined in 3133(d).

(c) The maximum number of permitted equivalent full range temperature cycles, *N*, is 100,000.

(d) The number of equivalent full range temperature cycles, *N*, is determined as follows:

$$= N_E + N_1\left(\frac{\Delta T_1}{\Delta T_E}\right)^{5.0} + N_2\left(\frac{\Delta T_2}{\Delta T_E}\right)^{5.0} + \ldots + N_n\left(\frac{\Delta T_n}{\Delta T_E}\right)^{5.0}$$

where

ΔT_E = maximum temperature change experience by the pipe, °F (°C)

N_E = number of cycles at maximum temperature change ΔT_E

$N_1, N_2, \ldots, N_n$ = number of cycles at lesser temperatures changes, ΔT_1, $\Delta T_2, \ldots, \Delta T_n$

$\Delta T_1, \Delta T_2, \ldots, \Delta T_n$ = the lesser temperature changes experienced by the pipe, °F (°C)

3200 SOIL AND SURCHARGE LOADS

3210 RING DEFLECTION

The soil and surcharge loads on a buried polyethylene pipe shall not result in a pipe diameter ring deflection, Ω, beyond the limit of Ω_{max} per Table 3210-1.

(U.S. Customary Units)

$$\Omega = \frac{100}{144} \times \frac{K \times L \times P_E + K \times P_L}{\frac{2E_{pipe}}{3} \times \left(\frac{1}{DR-1}\right)^3 + 0.061 \times F_S \times E'} \leq \Omega_{max}$$

(U.S. Customary Units)

$$P_E = [\rho_{saturated} \text{ x } H_{gw} + \rho_{dry} \text{ x } (H - H_{gw})]$$

E_{pipe} must be taken at the maximum life specified in the Design Specification, $K = 0.1$, and $L = 1.25$ to 1.5, or 1.0 if using soil prism pressure.

3220 COMPRESSION OF SIDEWALLS

The circumferential compressive stress in the sidewalls σ_{sw} due to soil and surcharge loads shall not exceed S_{comp} per Table 3220.

(U.S. Customary Units)

$$\sigma_{SW} = \frac{(P_E + P_L) \text{ x } DR}{2 \text{ x } 144} \leq S_{comp}$$

3221 External Pressure

3221.1 Buckling Due to External Pressure. The following shall be met to ensure the pipe does not fail due to the effects of applied external pressure and possible negative internal pressure

*(a)*When the depth of cover is greater than 4 ft (1.25 m) or one pipe diameter, whichever is larger, the external pressure from ground water (flooding), earth loads, surcharge loads, and air pressure (due to negative internal pressure at minimum internal gage pressure) on a buried polyethylene pipe shall not cause the pipe to buckle. The following equation shall be met:

$$P_{hydro} = \Delta P + \frac{P_E + P_L + P_{gw}}{144} \leq 2.8 \sqrt{\frac{R \times B' \times E' \times E_{pipe}}{12(DR-1)^3}}$$ (U.S. Customary Units)

In addition, the requirements of 3221.2 shall also be met.

(b) When the depth of cover is less than 4 ft (1.25 m) or one pipe diameter (whichever is larger), the pipe must withstand the combined external pressure of ground water (flooding), earth, surcharge and air without credit for the surrounding soil. In this case the following equation shall be met:

$$\Delta P + \frac{P_E + P_L + P_{gw}}{144} \leq \frac{f_0}{2} \times \frac{2E_{pipe}}{(1-\nu^2)} \times \left(\frac{1}{DR-1}\right)^3$$ (U.S. Customary Units)

$\nu = 0.45$ for all loads.

In this case, the requirements of 3221.2 do not need to be met.

The buoyancy reduction, R, and burial, B', factors are

$$R = 1 - 0.33 \text{ x } (H_{gw}/H)$$

(US Customary Units)

$$B' = \frac{1}{1 + 4 \text{ x } \exp(-.065 \text{ x } H)}$$

3221.2 Effects of Negative Internal Pressure. When the depth of cover is greater than 4 ft (1.25 m) or one pipe diameter (whichever is larger), the pipe must withstand the external air pressure resulting from negative internal pressure at the design minimum internal gage pressure without credit for the surrounding soil. This shall be ensured by meeting the following equation:

$$\Delta P \leq \frac{f_o}{2} \times \frac{2E_{pipe}}{(1-v^2)}\left(\frac{1}{DR-1}\right)^3$$

v is defined in 3221.1

3222 Flotation

Buried polyethylene pipe shall have sufficient cover or be anchored to the ground to prevent flotation by groundwater. To ensure this occurs, the following relationship shall be satisfied:

(U.S. Customary Units)

$$W_W < W_P + (P_E \text{ x } D/12)$$

3223 Longitudinal Stress Design

3223.1 Longitudinal Applied Mechanical Loads. Longitudinal stresses due to axial forces and bending moments resulting from applied mechanical loads shall not exceed K' x S.
where

$$\left(B_1 \times \frac{P_a \times D}{2 \times t}\right) + 2\left(B_1 \times \frac{F_a}{A}\right) + \left(B_2 \times \frac{M}{Z}\right) \leq K' \times S$$

The value of K' is given in Table 3223-1. The values of B_1, B_2 are given in Table 3311-1 and S is per Table 3131-1(a) or (b).

3223.2 Short Duration Longitudinal Applied Mechanical Loads. For the assessment of short duration loads (less than five minutes), the allowable stress, S, may be replaced by one of the following two alternatives:

(a) 40% of the material tensile strength at yield, or

(b) the values in Table 3223-2

3300 TEMPERATURE DESIGN

3310 MINIMUM TEMPERATURE

The polyethylene material shall not be used at a temperature below the manufacturer's limit, but in no case shall the temperature be less than minus 50°F .

3311 Design for Expansion and Contraction

3311.1 Fully Constrained Thermal Contraction.

The stress resulting from the assumption of fully constrained thermal contraction of the buried pipe when $T_{water}<T_{ground}$, increased by the stress due to axial contraction from Poisson's effect, shall be determined as follows:

$$\sigma_{rc}= \left|E_{pipe} \text{ x } \alpha \text{ x } \Delta T - v \text{ x} \frac{P \text{ x} D}{2 \text{ x} t}\right| \leq S_A$$

3311.2 Fully Constrained Thermal Expansion. The stress resulting from the assumption of fully constrained thermal expansion of the buried pipe when $T_{water}>T_{ground}$, shall be determined as follows:

$$\sigma_{re} =\left|E_{pipe} \text{ x } \alpha \text{ x } \Delta T\right|$$

3311.3 Combined Thermal Expansion and Contraction Stress

The combined thermal expansion and contraction stress shall be limited to S_A.

$$\left|\sigma_{rc}\right|+\left|\sigma_{re}\right| \leq S_A$$

S_A is per 3133.

3311.4 Alternative Thermal Expansion or Contraction Evaluation. As an alternative to 3311.1 and 3311.2, the soil stiffness may be accounted for to calculate pipe expansion and contraction stresses. The stresses shall satisfy the following equation:

$$\sigma_{Alt}= \frac{iM_c}{Z} + \frac{F_{aC}}{A} \leq S_A$$

S_A is per 3133.

3312 Non-repeated Anchor Movements

The effects of any single non-repeated anchor movements shall meet the requirements of the following equation:

$$\frac{iM_D}{Z} + \frac{F_{aD}}{A} < 2S$$

S is per Table 3131-1(a) or (b).

3400 SEISMIC DESIGN

3410 SEISMIC INDUCED STRESSES

The stresses in the buried polyethylene piping system due to soil strains caused by seismic wave passage, seismic soil movement, and building seismic anchor motion effects, where applicable, shall be evaluated. The stresses shall satisfy the following equation:

$$\frac{iM_E}{Z} + \frac{F_{aE}}{A} \leq S_A$$

S_A is per 3133.

Seismic wave passage, seismic soil movement, and building seismic anchor motion loads shall be combined by square root sum of the squares.

3500 OTHER DESIGN CONSIDERATIONS

Other facets of design, including but not limited to detailed pipe routing and interface connections, Appendix R fire protection, associated civil/structural modifications, and excavation and backfill, will be addressed under SNC design procedures in accordance with the existing design and license basis for Plant Hatch.

TABLE 3131-1(a)
LONG-TERM ALLOWABLE STRESS, S FOR POLYETHYLENE (psi)
(Values reflect a design factor, DF, of 0.50.)

Temperature (°F)	≤ 50 yrs	Temperature (°F)	≤ 50 yrs	Temperature (°F)	≤ 50 yrs
≤ 73	800	96	689	119	587
74	795	97	684	120	582
75	790	98	680	121	578
76	785	99	675	122	574
77	780	100	670	123	570
78	775	101	666	124	565
79	770	102	661	125	561
80	765	103	657	126	557
81	760	104	652	127	553
82	755	105	648	128	549
83	751	106	643	129	545
84	746	107	639	130	540
85	741	108	634	131	536
86	736	109	630	132	532
87	731	110	626	133	528
88	726	111	621	134	524
89	722	112	617	135	520
90	717	113	612	136	516
91	712	114	608	137	512
92	708	115	604	138	508
93	703	116	599	139	504
94	698	117	595	140	500
95	694	118	591		

GENERAL NOTE: The stresses listed in Tables 313I-1(a) and (b) support a 50 yr operating life; stresses for operating lives longer than 50 yr are under development.

TABLE 3131-1(b)
ELEVATED TEMPERATURE ALLOWABLE STRESS *S* FOR POLYETHYLENE (psi)
(Value reflects a design factor, DF, of 0.50.)

Temperature (°F)	≤ 0.3 yrs
≤ 176	341

Table 3133-1 - S_A, Allowable Secondary Stress Limit (psi) [1]

Number of Equivalent Full Range Temperature Cycles, N	The Higher of the Design Temperature or the Maximum Level A or Level B Service Temperature (° F)							
	≤ 70	80	90	100	110	120	130	140
N ≤ 1000	3930	3770	3610	3440	3280	3110	2930	2760
1000 < N≤ 10000	2600	2500	2400	2300	2190	2084	1980	1860
10000 < N≤ 25000	2200	2120	2040	1950	1870	1780	1690	1590
25000 < N≤ 50000	1950	1880	1800	1730	1650	1580	1500	1420
50000 < N≤ 75000	1830	1770	1700	1630	1540	1470	1400	1320
N_E> 75000	1720	1660	1600	1530	1470	1400	1330	1360

[1] Linear Interpolation of stress between temperatures is permitted

Table 3210-1 Maximum Allowable Ring Deflection Ω_{max}

DR	Ω_{max} (%)
13.5	6.0
11	5.0
9	4.0
7.3	3.0

Table 3210-2 Soil Support Factor, F_S

E'_N/E'	$(12*B_d)/D$, in/in					
	1.5	**2.0**	**2.5**	**3.0**	**4.0**	**5.0**
0.1	0.15	0.30	0.60	0.80	0.90	1.00
0.2	0.30	0.45	0.70	0.85	0.92	1.00
0.4	0.50	0.60	0.80	0.90	0.95	1.00
0.6	0.70	0.80	0.90	0.95	1.00	1.00
0.8	0.85	0.90	0.95	0.98	1.00	1.00
1.0	1.00	1.00	1.00	1.00	1.00	1.00
1.5	1.30	1.15	1.10	1.05	1.00	1.00
2.0	1.50	1.30	1.15	1.10	1.05	1.00
3.0	1.75	1.45	1.30	1.20	1.08	1.00
5.0	2.00	1.60	1.40	1.25	1.10	1.00

TABLE 3210-3
MODULUS OF ELASTICITY OF POLYETHYLENE PIPE E_{pipe} (psi)

Load	Temperature (°F)								
Duration	≤ 73	80	90	100	110	120	130	140	176
0.5 hr	82000	76300	67200	59900	52500	47600	41000	35300	18000
1 hr	78000	72500	64000	56900	49900	45200	39000	33500	17200
10 hr	65000	60500	53300	47500	41600	37700	32500	28000	14200
24 hr	60000	55800	49200	43800	38400	34800	30000	25800	13200
100 hr	55000	51200	45100	40200	35200	31900	27500	23700	12100
1000 hr	46000	42800	37700	33600	29400	26700	23000	19800	10100
1 yr	40000	37200	32800	29200	25600	23200	20000	17200	8800
10 yr	34000	31600	27900	24800	21800	19700	17000	14600	N/A
50 yr	29000	27000	23800	21200	18600	16800	14500	12500	N/A

Table 3220
ALLOWABLE SIDE WALL COMPRESSION STRESS S_{comp} (psi)

Temperature (°F)	S_{comp}
≤ 50	1180
73	1015
140	520
160	400
180	325

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Table 3221.2-1 Ovality Correction Factor, f_o

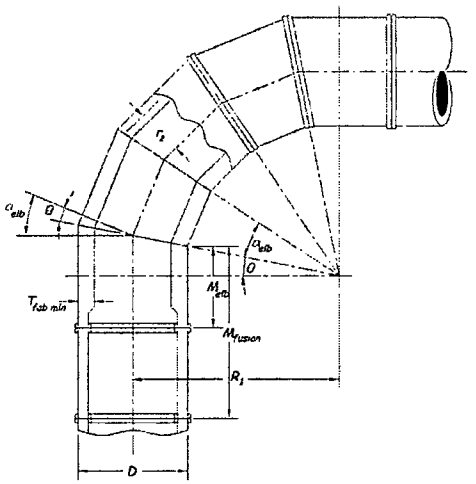
Percent-Ovality	Ovality Correction Factor
1 %	0.91
2 %	0.84
3 %	0.76
5 %	0.64
6 %	0.59

Table 3223-1
Design and Service Level Longitudinal Stress Factor, K'

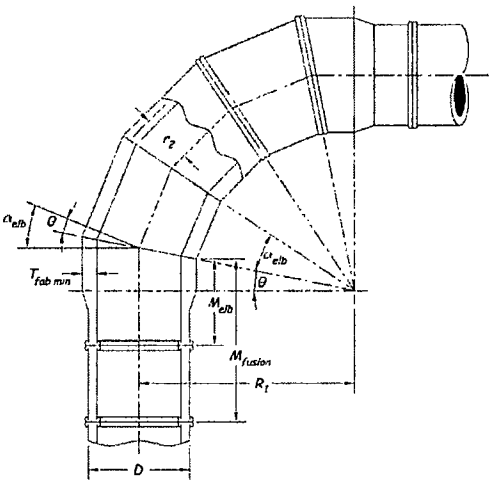
Service Level	Design	A	B	C	D
K'	1.0	1.0	1.1	1.33	1.33

Table 3223-2
Short Duration (<5 minutes) Allowable Longitudinal Tensile Stress

Temp, °F	≤70	100	120	140	176
S, psi	1200	940	770	630	400



(a): Constant OD, 5-Segment, Reinforced, 90 Degree Elbow

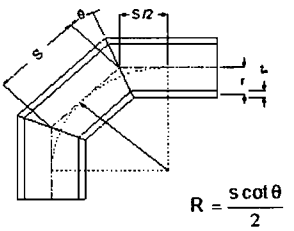


(b): Constant ID, 5-Segment, Reinforced, 90 Degree Elbow

Figure 3132-1: Nomenclature for Mitered Elbows

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Table 3311-1: STRESS INDICES, FLEXIBILITY, AND STRESS INTENSIFICATION FACTORS FOR PE PIPING COMPONENTS [NOTE (1), (2)]

Description	Primary Stress Index		Flexibility Characteristic h	Flexibility factor k	Stress Intensification Factors i	Sketch
	B_1	B_2				
Straight Pipe	0.5	1.0	N/A	1.0	1.0	N/A
Butt Fusion Joint	0.5	1.0	N/A	1.0	1.0	N/A
Miter Elbow $s \geq r(1+\tan\theta)$ [Note (3) and (4)]	0.69	Note (5)	$\frac{(1+\cot\theta)}{DR-1}$ or $\frac{t_n(1+\cot\theta)}{2r}$	In-plane Loading: $\frac{1.1}{h^{5/6}}$	$\frac{1.7}{h^{2/3}}$	
Machined Metallic to PE Bolted Flange Connection	0.5	1.0	N/A	1.0	1.0	See Fig. 4720-1

Notes to Table:

(1) The following nomenclature applies to this Table only for use in determining stress indices, stress intensification factors, and flexibility factors

D_o = Nominal outside diameter, in
r = Mean radius of pipe (in) (matching pipe for elbows and tees)
R = Nominal bend radius of elbow or pipe bend, in
θ = One-half angle between adjacent miter axes, deg
s = Miter spacing at center line, in
t_n = Nominal wall thickness of pipe, (t_{fabmin}) in (matching pipe for elbows and tees)
DR = Pipe Dimension Ratio = D_o/t_n

(2) The stress indices i and the flexibility factors k shall not be taken as less than 1.0. They are applicable to moments in any plane for fittings except as noted.

(3) One-half miter angle (θ) is limited to ≤ 11.25°.

(4) The flexibility factor k is only applicably for in-plane bending moment loading.

(5) The B_2 stress indices for mitered bends and molded elbows are dependent upon the DR and shall be as follows:

- 1.38 for DR 7
- 1.64 for DR 9
- 1.91 for DR 11
- 2.21 for DR 13.5

(6) All abutting piping fittings of differing DR's shall meet 4231

4000 FABRICATION AND INSTALLATION

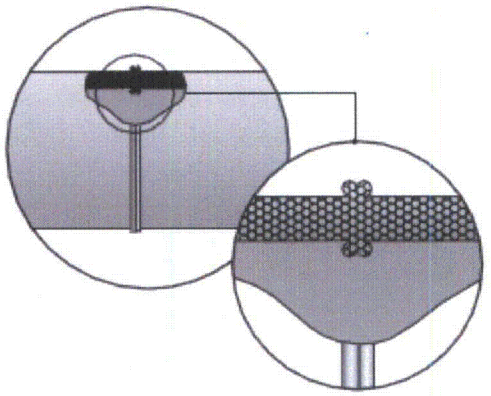
4100 GENERAL REQUIREMENTS

4110 INTRODUCTION

(a) Components, parts, and appurtenances shall be fabricated and installed in accordance with the rules of this Article and shall be manufactured from polyethylene materials that meet the requirements of 2000. Methods of fabrication and installation shall be by thermal butt fusion and flanged joints. Use of threaded or adhesive joints with polyethylene material shall not be permitted.

(b) Only the thermal fusion circumferential butt joints and miter joints may be used for pressure boundary fusion joints. See Fig. 4110-1.

Fig. 4110-1 THERMAL FUSION BUTT JOINT



(c) Branch connections shall not be permitted in polyethylene material.

(d) All metallic interface items shall be fabricated and installed in accordance with the requirements of the original Construction Code.

(e) Hereinafter all requirements specified in this section shall apply to fabrication and installation of polyethylene material.

4120 Examinations

Visual examination activities specified by 4130 or in 5000, or that are performed to verify compliance with requirements of 4000, are to be performed by personnel and procedures qualified in accordance with 5400 unless otherwise specified.

4130 REPAIR OF MATERIAL

Material upon receipt shall meet the surface acceptance criteria of 2400. All polyethylene material external surfaces shall be given an additional visual examination prior to installation. For pipe larger than IPS 4, any indentation greater than 0.040" shall be unacceptable. Indentations of 0.040" or less shall be acceptable provided that the remaining pipe wall thickness is greater than t_{design}.

4131 Elimination of Surface Defects

Pipe surface gouges or cuts greater than 0.040" in pipe greater than IPS 4 shall be removed by grinding or machining in accordance with the following requirements:

(a) The cavity has a minimum taper of 3:1 (half-width of the overall area to depth) without any sharp edges.

(b) The remaining wall thickness is in excess of t_{design} as required by this ATR.

(c) As an alternative to (1) and (2), the damaged portion may be removed and discarded.

4132 Flange Adapters

(a) Damage in the pipe section in the transition between the pipe section and the hub section, shall necessitate flange adapter replacement.

(b) For damage in the pipe section or hub section, the repair requirements of 4131(a) shall apply.

(c) Damage in the flange face (hub) shall be repaired by machining only if after the repair the minimum hub dimensional requirements of ASTM F2880 are met.

4200 FORMING, FITTING, AND ALIGNING

4210 CUTTING, FORMING, AND BENDING

4211 Cutting

Material shall be cut to shape and size by mechanical means.

4212 Forming and Bending Processes

The material shall not be cold or hot formed or bent except as follows:

(a) During installation, a pipe radius of curvature greater than or equal to thirty (30) times the outside diameter is permitted for piping with DR equal to or less than 13.5 except as restricted by (b).

(b) During installation a pipe radius of curvature for pipe with a DR 14 or higher, and for all pipe within two outside diameters of a flange connection or mitered elbow (measured from the pipe to fitting fused joint) shall not have a radius of curvature less than one hundred (100) pipe outside diameters.

4213 Minimum Thickness of Fabricated Items

If any operation reduces the thickness below the minimum required to satisfy the rules of 3000 and 4130, the material shall be discarded.

4230 FITTING AND ALIGNING

4231 Fitting and Aligning Methods

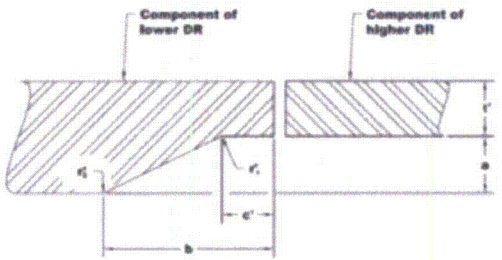
Items to be joined shall be fitted, faced, aligned, and retained in position during the fusing operation using appropriate fusing machines.

(a) Items of different outside diameters shall not be fused together except as provided in (c).

(b) The alignment surface mismatch shall be less than 10% $t_{fab\ min}$ of the items being fused.

(c) For items with differing DRs, the item with the smaller DR shall be counterbored and tapered to equal the wall thickness, or its outside diameter shall be machined and tapered to equal the wall thickness of the item with the larger DR and shall comply with Fig. 4230-1 (a) or (b).

Fig. 4230-1 Tapered Transition Joint



$t' = t_{fab\ min}$ of thinner component

$c'_{min} = 2.5t'$

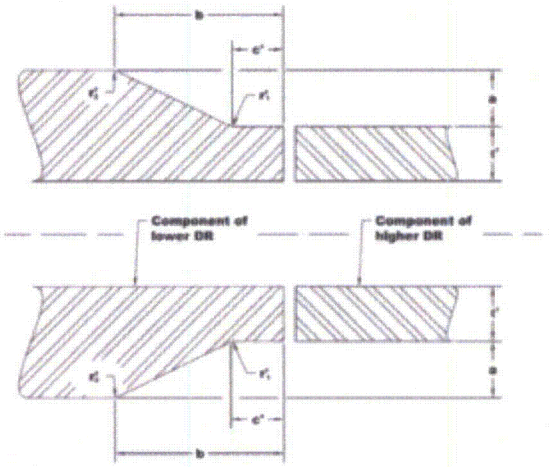
c'values are after facing

$$0.35 < \left[\frac{a}{(b-c')}\right] < 0.60$$

$r_1'_{min} = 0.05t'$

$r_2'_{min} = 0.05t'$

(a) Reinforcement on Inside Diameter



$t' = t_{fab\ min}$ of thinner component

$c'_{min} = 2.5t'$

c'values are after facing

$$0.35 < \left[\frac{a}{(b-c')}\right] < 0.60$$

$r_1'_{min} = 0.05t'$

$r_2'_{min} = 0.05t'$

(b) Reinforcement on Outside Diameter

4250 JOINT END TRANSITIONS

The joint end transitions of items shall provide a gradual change in thickness from the item to the adjoining items and shall comply with 4231(c) and Fig.4230-1.

4300 FUSING QUALIFICATIONS

4310 GENERAL REQUIREMENTS

4311 Types of processes permitted

Only those fusing processes that are capable of producing fused joints in accordance with fusing procedure specifications qualified in accordance with Supplement 3 of this ATR may be used for fusing pressure retaining material. Any process used shall be such that the records required by 4320 can be prepared.

4315 Fusing Operator Training

(a) Each fusing machine operator shall receive a minimum of 24 hr of training, covering the principles of the fusion process and the operation of the fusing equipment. There shall be a two part test at the end of this training:

(1) The written theoretical knowledge part of the test shall cover as a minimum: safety, fundamentals of the fusing process, and recognition of typical joint imperfections.

(2) The practical knowledge portion shall include hands-on training using equipment make and models to be used in production.

(3) Successful completion of this training shall be documented on the performance qualification record.
(4) Performance qualification testing shall be performed and documented in accordance with this ATR and Supplement 3.

(b) Non-mandatory Supplement A provides guidance for the training program.

4320 FUSING QUALIFICATIONS, RECORDS, AND IDENTIFYING STAMPS

4321 Required Qualifications

(a) The Owner (or approved Certificate Holder) is responsible for the fusing done by its organization and shall establish the procedure and conduct the tests required by Supplement 3 of this ATR, in order to qualify both the fusing procedures and the performance of fusing operators who apply these procedures.

(b) Procedures and fusing machine operators used to join pressure parts shall also meet the training, testing and qualification requirements of this ATR. Mitered joints shall be fused using procedures and personnel qualified for butt welded joints in accordance with this ATR and Supplement 3.

(c) The make and model of each fusing machine carriage to be used in production shall be performance tested on all diameters and thicknesses to be fused in accordance with 2300. As an alternative, the testing – or applicable portions thereof - may be performed by the Owner prior to installation. Machines to be used at angles exceeding 10° slope shall be tested at the maximum slope and drag to be applied. The tested machine make(s) and model(s) and maximum slope of use shall be documented on the fusing procedure specification (FPS).

4322 Maintenance and Certification of Records

The Owner shall maintain records of qualified fusing procedures and the fusing machine operators qualified by them, showing the date and results of each test and the identification mark assigned to each fusing operator. These records shall be reviewed, verified, and certified by the Owner (or approved Certificate Holder) and shall be available to the Inspector.

4322.1 Identification of Joints by Fusing Operator

Each fusing operator shall apply the identification mark assigned to him adjacent to all permanent fused joints. The marking shall be 1 ft (0.3 m) or less from the fusion bead and shall be done with permanent metallic paint marker or stenciling marker.

4323 Fusing Prior to Qualification

No production fusing shall be performed until after the FPS's which are to be used have been tested and verified in accordance with 2300. Only fusing procedures and operators qualified in accordance with this ATR and Supplement 3 shall be used. Only fusing machine models tested in accordance with 2300 shall be used for production.

4324 Transferring Qualifications

The fusing procedure qualification, testing and verification, or performance qualification tests for fusing operators, conducted by another organization shall not qualify fusing procedures or fusing operators to fuse for the Owner (or approved Certificate Holder).

4330 GENERAL REQUIREMENTS FOR FUSING PROCEDURE QUALIFICATION TESTS

4331 Conformance to Supplement 3

All fusing procedure qualification tests shall be in accordance with the requirements of Supplement 3 and this ATR.

4332 Preparation of Test Coupons and Specimens

Removal of test specimens from the fusion test coupon and the dimensions of specimens shall conform to the requirements of Supplement 3.

4335 Performance of Testing

Testing shall conform to the requirements of Supplement 3, except that Elevated Temperature Sustained Pressure Tests for Pipe shall be performed in accordance with ASTM D3035 or ASTM F714.

4340 GENERAL REQUIREMENTS FOR PERFORMANCE QUALIFICATION TESTS

4341 Conformance to Supplement 3

All fusing operator performance qualification tests shall be in accordance with Supplement 3 and this ATR.

4342 Additional Requirements

(a) The minimum pipe size shall be IPS 8 DR 11.

(b) A data acquisition device shall be attached to the fusing machine for recording the data concerning the joint required by Supplement 3, QF-131.

(c) The visual examination required by Supplement 3, QF-305 shall be performed over the entire inside and outside surfaces of the coupon.

(d) Bend specimens shall be tested in accordance with Supplement 3, QF-143. The specimens shall not crack or separate in the fused joint. (e) As an alternative to the bend testing prescribed in Supplement 3, High Speed Tensile Impact Testing may be performed in accordance with Supplement 3. Not less than four specimens shall be removed from fused pipe test coupons $\geq$ IPS 4 at intervals approximately 90 degrees apart.

4400 RULES GOVERNING MAKING, EXAMINING, AND REPAIRING FUSED JOINTS

4410 PRECAUTIONS TO BE TAKEN BEFORE FUSING

4411 Identification, Storage and Handling of Materials

The Owner (or approved Certificate Holder) is responsible for control of the materials that are used in the fabrication and installation of components. Suitable identification, storage, and handling of material shall be maintained.

4412 Cleanliness and Protection of Fusing Surfaces

The surfaces of the heater used for fusing shall be free of scale, rust, oil, grease, dust and other deleterious material. The joint shall be protected from deleterious contamination and from rain, snow, dust and wind during fusing operations. Fusing shall not be performed on wet surfaces or surfaces containing dust.

(a) Fusing shall not be performed at ambient temperatures less than 50°F, unless an environmental enclosure is used to control work area temperature at or above 50°F.

(b) Fusing shall not be performed at ambient or material temperatures above 125 °F. At ambient or material temperatures between 100°F and 125°F, the minimum cooling time (Supplement 3, QF-221) shall be increased to 13 minutes per inch of thickness.

4420 RULES FOR MAKING FUSED JOINTS

4421 Heating Cycle

(a) Immediately prior to inserting the heater plate between the faced ends to be joined, the temperature shall be verified to be within the required range by measuring at four locations approximately 90 degrees apart in the fusing zone, on both sides of the heater plate.

(b) Care shall be taken upon heater removal to ensure uniform flat heated surfaces on both pipe ends of the joint prior to fusing together.

4423 Surfaces of Fused Joints

Fused beads shall remain intact after completion of fusing.

(a) When required, fused beads may be removed, but only after the visual inspection required by 5210(b) is completed and documented. The entire surface at the removed bead locations shall be inspected in accordance with 5322.

(b) The finished joint shall be suitable for required visual and volumetric examinations.

4424 Joint Transitions

When items of different diameters are fused together, there shall be a gradual transition between the two surfaces in accordance with 4231(c).

4440 FUSING DATA ACQUISITION RECORDER

The fusing machine shall have a data acquisition recorder attached to it for each joint fused in accordance with this Article. The data acquisition record produced by the device shall include the information specified in Supplement 3. In addition, job information related to the joints such as job number and joint number shall be recorded. The data acquisition device shall be capable of a minimum of one (1) day of butt fusion joint information and capable of downloading this information as a permanent record.

(a) Failure of a recorder to operate properly during the fusion process shall cause removal and replacement of the fused joint.

(b) The data acquisition records shall be compared to the FPS to ensure that the proper butt fusing parameters and procedures were followed. If any parameter is outside the approved range, the fused joint shall be removed and replaced in compliance with the FPS or the item shall be scrapped.

(c) Verification of fusing parameters and variables not included in the data acquisition record shall be documented in accordance with the Owner's (or approved Certificate Holder's) Quality Assurance Program.

4450 REPAIR OF FUSED JOINTS

4451 General Requirements

(a) Indications of defects in fusion joints detected by the examinations required by 5000, or by the tests of 6000, shall cause rejection of the joint. Repair of a fused joint is not permitted. All unacceptable joints shall be removed and replaced.

(b) Fusion beads are not required to remain intact. Damaged fusion beads shall be evaluated to verify no infringement upon the fusion joint or adjacent base material. Damaged portions of fusion beads shall be removed if necessary to perform this evaluation.

4452 Elimination of Surface Defects

Surface defects may be removed by grinding or machining in accordance with the requirements of 4131. The removal area shall be re-examined in accordance with 5322.

4700 MECHANICAL JOINTS

4710 BOLTING AND THREADING

4711 Thread Engagement

The threads of all bolts or studs shall be engaged in accordance with the design. Flange bolting shall be engaged as required by 4720.

4712 Thread Lubricants

Any lubricant or compound used in threaded joints shall be suitable for the service conditions and shall not react unfavorably with either the service fluid, polyethylene material or any other material in the system

4720 FLANGED JOINTS

(a) Only flanged connections are permitted for joining of polyethylene pipe to metallic pipe or piping components. The polyethylene flange connection shall be constructed using a polyethylene flange adapter having a DR ratio equal to the attached polyethylene pipe, and joined by fusion to the attached pipe.

(b) The polyethylene flange adapter shall be connected to the metal flange using a metallic backing ring. The backing ring shall have a pressure rating equal to or greater than the metal flange.

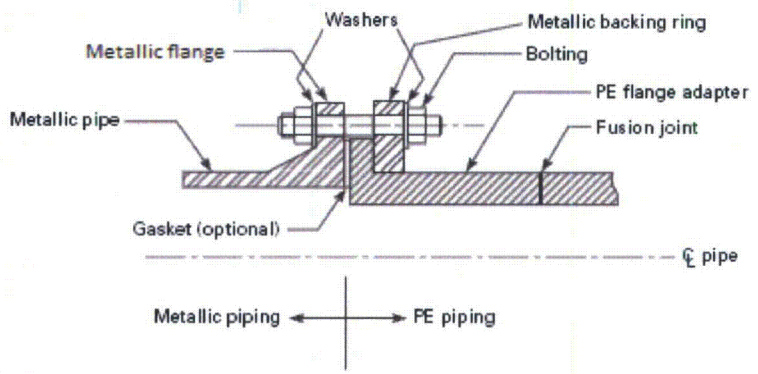
(c) Before bolting up, flange faces shall be aligned to the design plane within 1/16 in./ft measured across any diameter; flange bolt holes shall be aligned within 1/8 in. maximum offset. Damage to the gasket seating surface on the polyethylene flange that would prevent the gasket sealing shall be evaluated per 4132(c). Use of a gasket is optional.

(d) The flange shall be joined using bolts of a size and strength that conforms to the requirements of ASME B16.5 or ASME B16.47 Series A, as applicable. Bolts or studs should extend completely through their nuts. Any bolts or studs which fail to do so are considered acceptably engaged if the lack of complete engagement is not more than one thread. Flat washers shall be used under bolt heads and nuts.

(e) In assembling flanged joints, the gasket, if used, shall be uniformly compressed to the proper design loading. Special care shall be used in assembling flanged joints in which the flanges have widely differing mechanical properties. Tightening to a predetermined torque is recommended. If used, no more than one gasket shall be used between contact faces in assembling a flanged joint. The gasket material shall be selected to be consistent and compatible with the service requirements of the piping system.

(f) See Fig. 4720-1 for a typical flange configuration

Fig. 4720-1 TRANSITION FLANGE ARRANGEMENT



4800 PIPE SUPPORTS

All installed supports for polyethylene piping shall meet the requirements of the Construction Code and the following:

(a) Piping shall be supported, guided, and anchored in such a manner as to prevent damage thereto. Point loads and narrow areas of contact between piping and supports shall be avoided. Suitable padding shall be placed between piping and supports where damage to piping may occur.

(b) Valves and equipment that would transmit excessive loads to the piping shall be independently supported to prevent such loads.

5000 EXAMINATION

5100 GENERAL REQUIREMENTS FOR EXAMINATION

5110 PROCEDURES, QUALIFICATION, AND EVALUATION

5111 General Requirements

(a) Visual examinations shall be conducted in accordance with ASME Section XI IWA-2210.

(b) The volumetric examination method used shall be demonstrated in accordance with this ATR and approved in accordance with 5112.

(c) All personnel qualified to perform visual and volumetric examinations required by this ATR, excluding the VT-2 visual examinations of 5210(c), shall receive the training as required for the fusing machine operator in 4321. The training shall include review and understanding of the inspection requirements of this section, including the visual inspection acceptance criteria of 5320. This training shall also include the use of a fusing machine to make a fused joint. Qualification as a fusing machine operator is not required. This training shall be documented on an NDE qualification record.

5112 Nondestructive Examination Procedures

All nondestructive examinations performed under this Article shall be performed in accordance with detailed written procedures, which have been proven by actual demonstration to the satisfaction of the Inspector. Written procedures, records of demonstration of procedure capability, and personnel qualification shall be available to the Inspector on request.

5113 Volumetric Examination Procedures

(a) The ultrasonic examination shall include the joint volume and includes the joint to base material interface and ¼ in. from the joint centerline into the joint base material (see Fig. 5220-1).

(b) The ultrasonic examination shall be performed using encoded (position and amplitude) examination techniques.

(c) A written ultrasonic examination procedure shall be developed in accordance with the format in Supplement 2 and qualified by performance demonstration per 5115(b).

The written ultrasonic examination procedure shall:

(1) Contain a statement of scope that specifically defines the limits of procedure applicability (e.g., minimum and maximum thickness, minimum and maximum diameter, scanning access).

(2) Specify which parameters are considered essential variables. The procedure shall specify a single value or a range of values for the essential variables.

(3) List the examination equipment, including equipment manufacturer and model or series.

(4) Define the scanning requirements such as beam angles, scan patterns, beam direction, maximum scan speed, extent of scanning, and access requirements.

(5) Contain a description of the calibration method (e.g., actions required to insure that the sensitivity and accuracy of the signal amplitude and time outputs of the examination system, whether displayed, recorded, or automatically processed, are repeated from examination to examination).

(6) Contain techniques for data interpretation and plotting.

5115 Qualification of Volumetric Examination Procedures

(a) All volumetric examination procedures shall be qualified in accordance with this ATR.

(b) Performance demonstration specimen(s) for volumetric examinations shall conform to the following requirements:

(1) The specimens shall be fabricated from the same polyethylene material being installed.

(2) The demonstration specimen(s) shall contain a joint representative of the joint to be examined, including the same fusing processes.

(3) The demonstration specimen scanning and joint surfaces shall be representative of the production surfaces to be examined as defined in the ultrasonic examination procedure.

(4) The demonstration specimens shall include both planar and volumetric fabrication type flaws (e.g., un-bonded area, lack of fusion, inclusions, and porosity in base material) representative of the fusing process of the production joints to be examined. Embedment of flaws in the specimens will consider potential for impact on structural integrity, potential precursors to slow crack growth, and long-term impact on ten-year ISI pressure testing.

(5) The demonstration specimens shall include inner diameter (ID) surface-connected flaws, embedded indications characterized as surface flaws (ID and OD surfaces), and embedded flaws characterized as subsurface indications in accordance with ASME Section XI, IWA-3000 flaw characterization requirements.

(6) The demonstration set shall include specimens with through-wall flaw sizes evenly distributed with the smallest flaw size of 0.040 in. (1 mm) or 10% of the thickness, whichever is larger, and the largest flaw size no greater than 90% of the thickness.

(c) The demonstration set shall include at least 15 flaws.

(d) The demonstration shall be considered acceptable if 100% of the detectable relevant flaws are identified, with no more than 20% false calls.

5120 TIME OF EXAMINATION OF COMPLETED FUSED JOINTS

All required non-destructive examination of fused joints shall be conducted:

(a) After the completion of the cooling period.

(b) before the joint becomes inaccessible in the burial trench.

5200 EXAMINATIONS

5210 VISUAL EXAMINATION

Visual examinations shall be performed on the following material and components.

(a) A VT-1 visual examination of all external surfaces, upon receipt, for visual evidence of flaws imposed by forces and objects during packaging, transport, and handling.

(b) A VT-1 visual examination of all fused joints, including review and verification of fusing data for the joint in accordance with 4430.

(c) A VT-1 Visual examination of all accessible external surfaces of piping after placement in the burial trench.

(d) A VT-2 visual examination of all piping and fused joints, during the hydrostatic test in accordance with 6220.

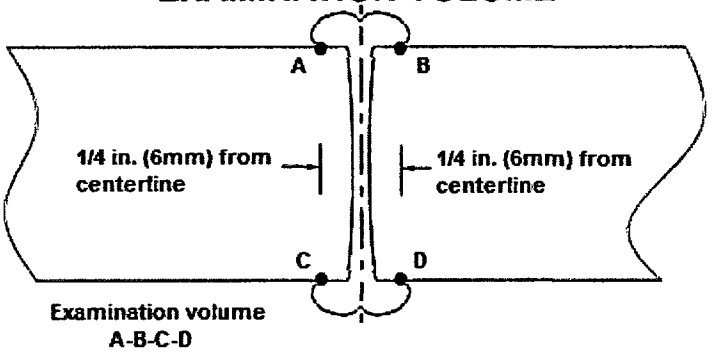
5220 ULTRASONIC EXAMINATION

All fused joints in pipe 4 in. outside diameter or greater shall be volumetrically examined.

(a) The examination volume shall include 100% of the area of interest shown in Figure 5220-1.

(b) Each joint shall also be examined 360 deg. using the techniques demonstrated in 5115 for detection of voids (un-bonded area, lack of fusion and porosity in base material).

Figure 5220-1
FUSION PIPE JOINT
EXAMINATION VOLUME



5300 ACCEPTANCE STANDARDS

5310 GENERAL REQUIREMENTS

Unacceptable fusion joints shall be removed. Repair of unacceptable fusion joints shall not be permitted.

5320 VISUAL EXAMINATION ACCEPTANCE CRITERIA OF EXTERNAL SURFACES

5321 Fused Butt Joints

Joints shall meet the following:

(a) Fused butt joints shall exhibit proper fusion bead configuration. Nonmandatory Supplement B depicts unacceptable thermally fused bead configurations.

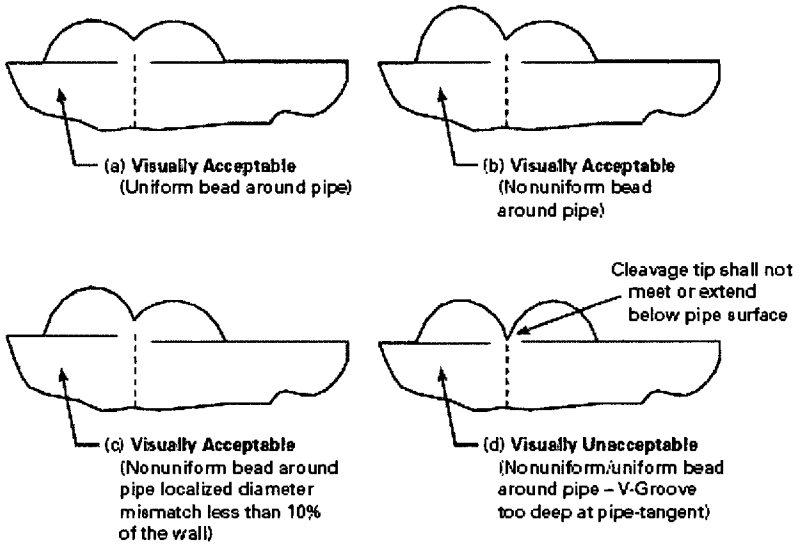
(b) There shall be no evidence of cracks or incomplete fusion.

(c) Fusion joints, except for miter joints, shall not be visually angled or offset by 3 degrees or more. The ovality offset shall be less than 10% $t_{fab\ min}$ of the fused items.

(d) The cleavage between fusion beads shall not extend to or below the OD pipe surface (see Fig. 5321-1).

(e) The data acquisition record for the fused joint shall be compared with the FPS to verify parameters and procedures were followed in making the fused joint.

FIG. 5321-1 POLYETHYLENE PIPE BUTT FUSION JOINT O.D. BEAD (CROSS SECTION VIEW)



5322 External Surfaces

Surfaces of all material shall meet the requirements of 4131.

Hydrostatic test acceptance criteria shall be in accordance with 6220.

5330 VOLUMETRIC EXAMINATION ACCEPTANCE CRITERIA

Any indication of a flaw not attributable to configuration that is identified in the examination volume shown in Figure 5220-1 shall cause the fused butt joint to be rejected.

5400 QUALIFICATION AND CERTIFICATION OF NONDESTRUCTIVE EXAMINATION PERSONNEL

5410 GENERAL REQUIREMENTS

Personnel performing visual examinations required for this ATR shall be qualified in accordance with ASME Section XI IWA-2300, and the Owner's NDE Program. This qualification shall be documented on a qualification record.

5420 PERSONNEL QUALIFICATION REQUIREMENTS

5421 Visual Examination

(a) Personnel performing visual examinations required by 5210 (a), (b) and (c) shall be qualified and certified as a VT-1, visual examiner, shall receive the required training in paragraph 5111(c), and shall be given a practical examination of physical samples of visually acceptable and unacceptable polyethylene pipe fused joints. A sample set with a minimum of ten flaws, including flaws representative of unacceptable conditions (Figure 5321-1) shall be used. The visual examination procedure shall be used and a passing grade of 80% detection of the intended flaws within the demonstration set is required. The

practical examination shall be administered by a Level III or designee. The training and examination results shall be documented in an NDE qualification record.

(b) Personnel performing visual examinations required by 5210(d) shall be qualified as a VT-2, visual examiner.

5422 Volumetric Examination

(a) Personnel performing ultrasonic examinations shall receive the required training in paragraph 5111(c).

(b) Volumetric examination personnel shall demonstrate their capability to detect flaws by performance demonstration using the qualified procedure in accordance with the following requirements:

(1) The personnel demonstration shall be conducted in a blind fashion (flaw information is not provided).

(2) The demonstration specimens shall be in accordance with 5115(b).

(3) The demonstration specimen set shall contain at least 10 flaws.

(4) At least 60% of the flaws shall be planar type flaws and at least 20% volumetric type flaws applicable to the fusing process.

(c) Personnel shall be considered qualified for flaw detection, if they report at least 80% of the intended flaws in the performance demonstration test, with 20% or less false calls. All other reported flaws shall be considered false calls.

(d) This examination shall be administered by a Level III or designee. The examination results shall be documented on a qualification record.

6000 TESTING

6100 GENERAL REQUIREMENTS

6110 PRESSURE TESTING

6111 Scope of Pressure Testing

(a) Prior to initial operation, the installed system shall be hydrostatically tested in the presence of the Owner's Authorized Nuclear Inservice Inspector.

(b) Bolts, studs, nuts, washers, and gaskets are exempt from pressure testing.

6112 Pneumatic Testing

A pneumatic test shall not be permitted.

6120 PREPARATION FOR TESTING

6121 Exposure of Joints

(a) All fusion joints, including the polyethylene flange adapter side of mechanical joints, shall be un-insulated and exposed for inspection during the test.

(b) For long sections of piping, the hydrostatic testing may be accomplished by testing in small subsections of the longer section. Upon a satisfactory test of each small section the piping may be buried. This process shall be documented in the Owner's Repair/Replacement Program and shall be acceptable to the Authorized Inspection Agency.

6200 HYDROSTATIC TESTS

The requirements of this section apply to all piping systems or piping subassemblies.

6210 HYDROSTATIC TEST PROCEDURE

6211 Venting During Fill Operation

The piping subassembly or piping system in which the test is to be conducted shall be vented during the filling operation to minimize air pocketing.

6212 Test Medium and Test Temperature

(a) Water shall be used for the hydrostatic test.

(b) The test shall be conducted at an ambient temperature that is within the temperature limits of the system design. The test pressure shall not be applied until the piping and the pressurizing fluid are at approximately the same temperature.

6220 HYDROSTATIC TEST PRESSURE REQUIREMENTS

6221 Minimum Hydrostatic Test Pressure

(a) The system shall be hydrostatically tested at not less than 1.5 times the Design Pressure +10 psi for four hours prior to leakage inspection.

6223 Hydrostatic Test Pressurization and Holding Time

(a) The pressure in the test section shall be gradually increased at a rate of between 5 psig/min. (34.5kPa/min.) minimum and 20 psig/min. (138KA/min.) maximum. Pressure shall be held at the test pressure for 4 hours, during which time make-up water may be added to maintain pressure due to initial expansion.

(b) After the 4 hour hold time, the test pressure shall be reduced by 10 psig, and make-up water may no longer be added to maintain pressure. The system pressure shall then be monitored for at least one hour, during which time there shall be no reduction in pressure greater than 5% of the test pressure. Satisfactory completion of this portion of the test shall satisfy pre-service inspection requirements for the portion of HDPE piping being tested.

(c) The total elevated test time greater than normal operating pressure, including initial expansion, and time at test pressure, shall not exceed 8 hours. If the pressure test is not completed in that time, the section shall be depressurized and not re-pressurized for at least 8 hours.

6224 Examination for Leakage After Application of Pressure

Following the application of the hydrostatic test pressure for the required time in accordance with 6223(a), and upon reduction in test pressure in 6223(b), examination for leakage shall be performed by personnel qualified in accordance with 5421(b).

(a) Each fused joint and all accessible external exposed surfaces shall be examined for leakage while at hydrostatic test pressure.

(b) For components whose external surfaces are inaccessible for direct visual examination, only the examination of the surrounding area (including areas or surfaces located underneath the components) for evidence of leakage shall be required.

(c) There shall be no leakage at fused joints or through the pressure boundary except as permitted in (d), below.

(d) Leakage of temporary gaskets and seals, installed for the purpose of conducting the hydrostatic test that will later be replaced, may be permitted unless the leakage exceeds the capacity to maintain system test pressure during the required examination.

(e) The examination shall be witnessed by the Inspector.

6300 Inservice Testing

Inservice pressure testing shall be performed in accordance with Supplement 5.

8000 NAMEPLATES, STAMPING AND DATA REPORTS

8100 GENERAL REQUIREMENTS

8110 SCOPE

Stamping is neither required nor prohibited. When stamping is required, stamping with the Certification Mark and Designator, and associated data reports for items constructed in accordance with this ATR shall be as required in NCA-8000, with the following exceptions:

(a) The attachment of nameplates, if required, shall be performed using an adhesive or corrosion resistant wire that is compatible with and will not degrade the polyethylene material.

(b) The polyethylene material manufacturer is permitted to apply the standard print line identifier to his piping product using a thermal process.

(c) No indentation stamping is allowed on the polyethylene pipe surface, and all marking shall be performed with a metallic paint marker or stenciling marker.

(d) Mitered elbows shall be furnished with Data Report Form NM(PE)-1 (Supplement 4) as required by 2233 of this ATR.

9000 GLOSSARY

Refer to ASME Section IX, QG-109, for definitions applicable to the fusing process. All other definitions shall be as given in ASME Section III, Subsection NCA-9000 with the following additions:

Hydrostatic Design Basis (HDB): one of a series of established stress values for a compound.

Hydrostatic Design Stress (HDS): the estimated maximum tensile stress the material is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. This stress is circumferential when internal hydrostatic water pressure is applied.

lot: the quantity of:

(a) Polyethylene Source Material documented on the Certificate of Analysis (COA) and related traceability documentation.

(b) Polyethylene Material documented on the Certified Product Test Report (CPTR).

modulus of soil reaction, E': the soil reaction modulus is a proportionality constant that represents the embedment soil's resistance to ring deflection of pipe due to earth pressure. E' has been determined empirically from field deflection measurements by substituting site parameters (i.e., depth of cover, soil weight) into Spangler's equation and "back calculating" E'.

polyethylene (PE): a polyolefin composed of polymers of ethylene. It is normally a translucent, tough, waxy solid which is unaffected by water and by a large range of chemicals. There are three general classifications: low-density, medium-density, and high-density.

void free: as relating to piping products, free from any detectable voids using the volumetric examination method approved by the Owner or their designee.

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

SUPPLEMENT 1 Applicable Standards

The PE material standards listed in the following table are applicable to the extent invoked by this ATR.

Referenced PE Standards and Specifications

Standard	Subject	Edition
ASTM Standards		
C638	Tensile Properties of Plastics	2010
D792	Density and Specific Gravity (Relative Density)of Plastics	2008
D1238	Melt Flow Rates of Thermoplastics	2010
D1505	Density of Plastics	2010
D1599	Short Term Hydraulic Pressure	R2005
D1603	Carbon Black Content of Olefin Plastics	2012
D2122	Determining Dimensions of Thermoplastic Pipe	R2010
D2290	Apparent Hoop Tensile Strength	2012
D2837	Obtaining Hydrostatic Design Basis	2011
D3035	Specification for Polyethylene Pipe – Controlled Outside Diameter	2012e1
D3350	Specification for Plastic Pipe & Fitting Material	2012
D4218	Determining Carbon Black Content in PE Compounds	R2008
D488	Density Measurement using Ultrasound	2008
F714	Specification for Polyethylene Pipe based on Outside Diameter	2010
F1473	Notch Tensile Test for Slow Crack Growth	2011
F2206	Specification for Fabricated Fittings	2011
F2880	Lap-Joint Type Flange Adaptors (applies only to flange adaptor hub dimensional requirements)	2011a
PPI Documents		
PPI TR-3	Developing Hydrostatic Design, Pressure Design, and Strength Design Bases, and Minimum Required Strength Ratings	2010a
PPI TR-4	Listing of Hydrostatic Design, Pressure Design, and Strength Design Bases, and Minimum Required Strength Ratings	Latest version
PPI TR-33	Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe	2012

SUPPLEMENT 2 – Ultrasonic Examination of High Density Polyethylene

2-110 SCOPE

This Mandatory Supplement describes the requirements to be used to examine fused butt welds in High Density Polyethylene (HDPE) using encoded pulse echo, using either Phased Array (PA) or Time of Flight Diffraction (TOFD) ultrasonic techniques.

2-120 GENERAL

The requirements of ASME Section V[5], Article 4, including Mandatory Appendix III or Mandatory Appendix V of that Article, as applicable, shall apply except as modified herein.

2-121.1 Procedure Qualification. The requirements of Table 2-121 of this ART (below), plus ASME Section V, Table T-421 and either Table III-422 or Table V-421 of Article 4 Appendices, shall apply, as applicable.

2-122 Scan Plan

A scan plan (documented examination strategy) shall be provided showing search unit placement and movement that provides a standardized and repeatable methodology for the examination. In addition to the information in ASME Section V, Article 4 Table T-421, and as applicable, Table III-422 or Table V-421 of Article 4 Appendices, the scan plan shall include beam angles and directions with respect to the weld axis reference point, weld joint geometry, and number of examination areas or zones.

TABLE 2-121
REQUIREMENTS OF AN ULTRASONIC EXAMINATION PROCEDURE FOR HDPE TECHNIQUES

Requirement (As Applicable)	Essential Variable	Nonessential Variable
Scan plan	X	...
Examination technique(s)	X	...
Computer software and Revision	X	...
Scanning technique (automated vs. semi-automated)	X	...
Flaw characterization methodology	X	...
Flaw sizing (length) methodology	X	...
Scanner and adhering and guiding mechanism	...	X
Search unit mechanical fixturing device	X	

[5] ASME Section V, 2010 or later Edition and Addenda.

2-130 EQUIPMENT

2-131.1 Instrument.

The requirements of ASME Section V, Article 4, T-431 and III-431.1 shall apply. In addition, when using PA ultrasonic examination, the following shall apply. An ultrasonic array controller shall be used. The instrument shall be capable of operation at frequencies over the range of at least 1 MHz to 7 MHz and shall be equipped with a stepped gain control in units of 2 dB or less and a maximum gain of at least 60 dB. The instrument shall have a minimum of 32 pulsers. The digitization rate and compression setting of the instrument shall be at least five times the search unit center frequency. Compression setting shall be not greater than used during qualification of the procedure.

2-131.2 Data Display and Recording.

When performing TOFD, the requirements of ASME Section V, Article 4, Appendix III-431.2 shall apply. When performing phased array ultrasonic testing, the following shall apply. The instrument shall be able to select an appropriate portion of the time base within which A-scans are digitized. The instrument shall be able to display A-, B-, C-, D-, and S-scans. A color palette able to differentiate between different amplitude levels in the A-scans to be presented in the B-, C-, D-, and S-scans must be available. The equipment shall permit storage of all A-scan waveform data, with a range defined by gates, including amplitude and time-base details. The equipment shall also store positional information indicating the relative position of the waveform with respect to adjacent waveform(s), i.e. encoded position.

2-132 Search Units

The requirements of ASME Section V, Article 4 T-432-1 and Appendix III-432.1 shall apply. In addition, when using phased array ultrasonic testing the following shall apply. The nominal frequency shall be from 1 MHz to 7 MHz unless variables, such as production crystalline microstructure, require the use of other frequencies to assure adequate penetration or better resolution. Longitudinal wave mode shall be used. The number of elements used shall be between 32 and 128. Search units with angled wedges may be used to aid coupling of the ultrasound into the inspection area.

2-133 Couplant

2-133.1 General The couplant (e.g., water and glycerin), including additives, shall not be detrimental to the HDPE material being examined, such as oxidizers, grease and motor oils.

2-134 Calibration Blocks

2-134.1.1 Reflectors.

2-134.1.1.1 Side-Drilled Hole (SDH)

The reference reflector shall be a maximum of 0.12 in. in diameter.

2-134.1.2 Material

The block shall be fabricated from pipe of the same pipe material to be used in production.

2-134.1.3 Quality. In addition to the requirements of ASME Section V, Article 4 T-434.1.3, areas that contain indications are unacceptable, regardless of amplitude.

2-134.3 Piping Calibration Blocks. The calibration block shall contain side-drilled holes (SDH) and a machined radius. The thickness of the block shall be at least as thick as the component under examination but not more than 125 percent *t* or ¼ in. whichever is less. Alternative calibration block designs may be utilized provided the calibration is demonstrated as required in 2-121.1. The block size and reflector locations shall be adequate to perform calibration for the beam angles used.

2-160 CALIBRATION

2-164 Calibration for Piping

2-164.1 System Calibration for Distance Amplitude Techniques

2-164.1.1 Calibration Block(s). Calibrations shall be performed utilizing the calibration block referenced in 2-134.3.

2-164.1.2 Straight Beam Calibration. Not required.

2-164.2 System Calibration for Non-Distance Amplitude Techniques. Calibrations include all those actions required to assure that the sensitivity and accuracy of the signal amplitude and time outputs of the examination system (whether displayed, recorded, or automatically processed) are repeated from examination to examination. Calibration shall be by use of the calibration block specified in 2-134.3 with artificial reflectors.

2-167 Calibration Confirmation

2-167.1 System Changes. When any part of the examination system is changed, a calibration check shall be made on the calibration block to verify that distance range point and sensitivity setting(s) of the deepest calibration reflector used in the calibration satisfy the requirements of 2-167.3.

2-167.2 Calibration Checks. A calibration check on at least one of the reflectors in the calibration block or a check using a simulator shall be performed at the completion of each examination or series of similar examinations, and when examination personnel (except for automated equipment) are changed. The distance range and sensitivity values recorded shall satisfy the requirements 2-167.3.

2-167.2.1 Material Verification. When examining material from a different production lot from that of the calibration block, a verification of the material velocity shall be made using a machined radius on a block manufactured from the new lot and any difference in the results be compensated for in both velocity and gain level.

NOTE: Interim calibration checks between the required initial calibration and the final calibration check may be performed. The decision to perform interim calibration checks should be based on ultrasonic instrument stability (analog vs. digital), the risk of having to conduct reexaminations, and the benefit of not performing interim calibration checks.

2-167.3 Confirmation Acceptance Values

2-167.3.1 Distance Range Points. If the distance range point for the deepest reflector used in the calibration has moved by more than 10% of the distance reading or 5% of full sweep, whichever is greater, correct the distance range calibration and note the correction in the examination record. All recorded indications since the last valid calibration or calibration check shall be reexamined and their values shall be changed on the data sheets or re-recorded.

2-167.3.2 Sensitivity Settings. If any sensitivity setting for the deepest reflector used in the calibration has changed, compensate for the difference when performing the data analysis, and note the correction in the examination record.

2-171.1 Examination Coverage[6]

The examination area of interest is shown in Fig. 5220-1.

2-171.6 Recording. A-scan data shall be recorded for the area of interest in a form consistent with the procedure qualification, and recording increments of a maximum of:

(a) 0.04 in. for material <3 in. thick

(b) 0.08 in. for material ≥3 in. thick.

2-192 Examination Record

For each examination, the required information of ASME Section V, Article 4 T-492, and either Appendix III-492 or Appendix V-492 as applicable shall be recorded. All inspection records, including A-scan recorded data, shall be retained.

[6] Numbering is based on Section V conventions; omitted paragraphs that are not applicable.

SUPPLEMENT 3 – Fusing Qualification Requirements

100 - GENERAL

QF-100 Scope
The rules in this Supplement apply to the preparation and qualification of the fusing procedure specification (FPS), and the performance qualification of fusing machine operators.

QF-101 Fusing Procedure Specification
The Fusing Procedure Specification (FPS) specifies the "variables" and "parameters"[7] including ranges, if any) under which fusing must be performed. The FPS prepared shall address the applicable fusing process variables and parameters, both essential and nonessential, as provided in this Supplement for production fusing.

QF-102 Fusing Performance Qualification
Fusing machine operator performance qualification is intended to verify the ability of the fusing machine operator to produce a soundly fused joint when following a qualified FPS. The fusing machine operator performance qualification record (FPQ) documents the performance test of the fusing machine operator, and the results of the required mechanical tests.

QF-110 Fused Joint Orientation
Orientation categories for fused joints are illustrated in Figure QF-461.1.

QF-120 Test Positions
Fused joints may be made in test coupons oriented in any of the positions shown in Figure QF-461.2.

QF-130 Data Acquisition and Evaluation
QF-131 Data Acquisition Record Requirements
The following fusing variables shall be recorded for each fused test joint:
(a) heater surface temperature immediately before inserting the heater plate
(b) gauge pressure during the initial heat cycle
(c) gauge pressure and elapsed time during the heat soak cycle
(d) heater removal (dwell) time
(e) gauge pressure and elapsed time during the fusing/cool cycle
(f) drag pressure
(g) joint configuration
(h) pipe diameter and wall thickness
(i) type of HDPE material (specification and classification) and manufacturer
(j) FPS used, operator identification, time, date, and fusing machine identification

[7] The term "parameters" is applied to variables or attributes not considered applicable by Section IX, but considered as applicable for nuclear applications.

QF-132 Data Acquisition Record Review

The data acquisition record for each test joint shall be compared to the FPS after completion. The following shall be verified:

(a) all data required by QF-131 was recorded

(b) interfacial fusing pressure was within the FPS range

(c) heater surface temperature recorded was within the FPS range

(d) butt-fusing pressure applied during the fusing/cool cycle was correctly calculated to include the drag pressure, fell within the FPS range for the applicable size (e.g., pipe diameter), and agrees with the recorded hydraulic fusing pressure

(e) butt-fusing pressure was reduced to a value less than or equal to the drag pressure at the beginning of the heat soak cycle

(f) fusing machine was opened at the end of the heat soak cycle, the heater was removed, and the ends brought together at the fusing pressure within the time frame specified by the FPS

(g) cooling time at butt-fusing pressure met the minimum time specified by the FPS

If the recorded data is outside the limits of the FPS, the joint is unacceptable.

QF-140 Examinations and Tests

QF-141 Visual Examination

(a) All fused joints shall receive a visual examination of all accessible surfaces of the fused joint.

(b) Acceptance Criteria (see Figure QF-462 for evaluation examples)

(1) There shall be no evidence of cracks or incomplete fusing.

(2) Joints shall exhibit proper fused bead configuration.

(3) Variations in upset bead heights on opposite sides of the cleavage and around the circumference of fused pipe joints are acceptable.

(4) The apex of the cleavage between the upset beads of the fused joint shall remain above the base material surface.

(5) The data record for the FPS or fusing machine operator performance qualification test shall be reviewed and compared to the FPS to verify observance of the specified variables applied when completing the fused test joint.

(6) Fused joints shall not display visible angular misalignment, and outside diameter mismatch shall be less than 10% of the nominal wall thickness.

(c) Visual examination results shall be recorded on the FPQ.

QF-143 Bend Tests

These tests are designed to impart bending stresses to a butt-fused plastic specimen to evaluate the soundness of the fused joint by visual evidence of failure.

QF-143.1 Reverse Bend Test (RBT)

(a) Reverse-bend test specimens shall be cut to a minimum width of 1.5 times the test coupon thickness for testing and removed as shown in Figure QF-463(a).

(b) One test specimen shall be bent to place the inside surface of the joint in tension, and the other test specimen shall be bent to place the outside surface of the joint in tension.

(c) The bending process shall ensure the ends of the specimens are brought into contact with one another.

(d) Testing shall be in accordance with ASTM F2620-09, Appendix X4.
(e) Test results shall be recorded on the FPQ.

QF-143.2 Guided Side Bend Test (GSBT)
QF-143.2.1 Significance and Use. This test is designed to impart a bending load on a specimen from a butt fusion joint to evaluate its soundness. It is intended for butt fusion joints of HDPE pipe with a wall thickness greater than 1.0 in. (25 mm).
QF-143.2.2 Test Specimens.
(a) Test specimens shall be removed from the fused test coupon with the upset bead remaining on the outside and inside surfaces. A strip having the full thickness of the test coupon and measuring approximately 1 in. (25 mm) wide and 18 in. (450 mm) long shall be removed along the longitudinal axis of the test coupon, with the joint located in the approximate center of the strip. See Figure QF-463(b).
(b) Plane or machine the width down to 0.50 in. ± 03 in. (13 mm ± 0.75 mm) with a smooth finish on both sides. See Figure QF-463(c).

QF-143.2.3 Test Conditions
(a) Test Temperature. Conduct the GSBT at a temperature 60°F to 80°F (16°C to 27°C).
(b) Test speed. The elapsed time of the test shall be between 30 sec and 60 sec.

QF-143.2.4 Guided Side-Bend Test Procedure
QF-143.2.4.1 Jigs. Test specimens shall be bent in a test jig consisting of a fixed member with two cross bars to support the specimen while force is applied. The hydraulic ram, used to supply the bending force, is also attached to the jig and has a ram attached to the end of the cylinder. See Figure QF-463(d).
QF-143.2.4.2 Bend Procedure. Position the side-bend test specimen with the butt fusion joint in the center of the jig between the support mandrels. Position the ram in the center of the fusion bead on the test specimen. Move the ram slowly until it makes contact with the test specimen and is positioned in line with the fusion bead. Begin to apply the bending force and deflect the side-bend test specimen. The test is complete when the test specimen is bent to an angle of 60 deg ± 10 deg between the inside surfaces of the specimen or until failure occurs. See Figure QF-463(d).

QF-143.3 Acceptance Criteria. The test specimen shall not break or exhibit cracking or fractures on the convex (outer) surface at the fusion interface during this test.

QF-144 High Speed Tensile Impact Test (HSTIT)
This test method is designed to impart tensile impact energy to a butt-fused PE pipe specimen to evaluate its ductility.

QF-144.1 Test Specimens
(a) Test specimens shall be removed from the fused test coupon with the upset bead remaining on the outside diameter and inside diameter surfaces. Specimens for test coupon thicknesses less than or equal to 2 in. (50 mm) shall include the full wall thickness of the fused joint. Specimens for test coupon thicknesses 2 in. (50 mm) and greater may be cut into approximately equal strips between 1 in. (25 mm)

and 2.5 in. (64 mm) wide for testing with each segment tested individually such that the full cross section is tested.
(b) Test specimens shall be prepared by machining to achieve the dimensions given in Figure QF-464, with the upset beads remaining intact.
(c) A smooth surface free of visible flaws, scratches, or imperfections shall remain on all faces of the reduced area with no notches, gouges, or undercuts exceeding the dimensional tolerances given in ASTM F2634-07. Marks left by coarse machining operations shall be removed, and the surfaces shall be smoothed with abrasive paper (600 grit or finer) with the sanding strokes applied parallel to the longitudinal axis of the test specimen.
(d) Mark the test specimens in the area outside the hole with the applicable specimen identification using a permanent indelible marker of a contrasting color, or an etching tool.
(e) Condition the test specimens at 73°F ± 4°F (23°C ± 2°C) for not less than 1 hr just prior to conducting the test.

QF-144.2 Test Conditions
(a) Test Temperature. Conduct the high speed impact test at a temperature of 73°F ± 4°F (23°C ± 2°C) unless otherwise specified.
(b) Test Speed. The speed of testing shall be in accordance with Table QF-144.2 with a testing speed tolerance of +0.5 in./sec to −1 in./sec (+13 mm/sec to −25 mm/sec).

Table QF-144.2
Testing Speed Requirements

Wall Thickness	Testing Speed
≤ 1.25 in. (32 mm)	6 in./sec (150 mm/sec)
> 1.25 in. (32 mm)	4 in./sec (100 mm/sec)

QF-144.3 Test Procedure
(a) Set up the machine and set the speed of testing to the rate specified in QF-144.2(b).
(b) Pin each specimen in the clevis tooling of the testing machine, aligning the long axis of the specimen and the tooling with the pulling direction of the test machine.
(c) Testing shall be performed in accordance with ASTM F2634.
(d) Evaluate the test specimen fracture to determine the mode of failure, and note the results in the test record.

QF-144.4 Test Record. The HSTIT shall be documented by preparing a test record that includes the following information:
(a) testing speed applied
(b) testing temperature observed
(c) specimen dimension verification
(d) test machine calibration data
(e) test specimen identification
(f) test date
(g) test operator identification

(h) testing failure mode and acceptance/rejection
(i) test equipment identification

QF-144.5 Acceptance Criteria. Failure mode shall be ductile, with no evidence of brittle failure at the fusion interface. See Figure QF-465, illustrations (a) through (d), for evaluation examples.

200 FUSING PROCEDURES

Each organization shall prepare a written FPS as defined in QF-201.1.

QF-201 Procedure Specifications

QF-201.1 Fusing Procedure Specification (FPS)

(a) Fusing Procedure Specification (FPS). A FPS is a written qualified fusing procedure prepared to provide direction to the fusing machine operator for making production fused joints.

(b) Contents of the FPS.

(1) The completed FPS shall address all of the essential variables and parameters for each fusing process used in the FPS. The essential and nonessential variables for fusing are listed in Table QF-254.

(2) The FPS shall also address all of the essential parameters identified in 2300 of the ATR, as well as the slope and ambient limitations of 4321 and 4412, and shall be restricted to material produced from DOW DGDA2492 bimodal polyethylene resin. The organization may include any other information in the FPS that may be helpful in making a fused joint.

(3) Changes in the documented essential variables or essential parameters requires retesting of the FPS.

QF-201.2 Plant Hatch Fusing Procedure Specification

The Plant Hatch fusing procedure specifications shall meet QF-201.1, and shall contain acceptable polyethylene fusing variables based on standard industry practice and testing as reported in the Plastic Pipe Institute (PPI), Report TR-33. This report demonstrates that the basic essential variables tested and results achieved are applicable to all sizes and thicknesses of PE4710 piping up to 36DR9.5. This testing does not address the essential parameters identified in QF-201.1, above. Therefore, the additional testing described in 2300 of this ATR is required to be performed under Plant Hatch 10CFR50 Appendix B QA Program before the FPS can be considered qualified for the Hatch project.

QF-201.3 Format of the FPS. The information required to be included in the FPS may be in any format, written or tabular, to fit the needs of each organization, provided all essential and nonessential variables outlined in QF-250, or the parameters specified in QF-220 as applicable, are addressed.

QF-201.4 Availability of the FPS. The FPS used for production fusing shall be available for reference and reviewed by the Inspector when fused joints are made.

QF-202 Type of Tests Required

QF-202.1 Mechanical Tests

QF-202.1.1 High-speed tensile impact test specimens (HSTIT) shall be prepared in accordance with

Figure QF-464 and tested in accordance with QF-144.1. For pipe specimens 4 NPS (100 mm) and greater: not less than four specimens removed from fused pipe test coupons at intervals approximately 90 deg apart.

QF-202.1.2 Elevated Temperature Testing is not applicable, as the basic essential variables have been validated under IPPI TR-33.

QF-202.1.3 If any test specimen required by QF-202.1 fails to meet the applicable acceptance criteria, the test coupon shall be considered unacceptable.
(a) When it can be determined that the cause of failure is not related to incorrectly selected or applied fusing variables, additional test specimens may be removed as close as practicable to the original specimen location to replace the failed test specimens. If sufficient material is not available, another test coupon may be fused utilizing the original fusing parameters.
(b) When it has been determined that the test failure was caused by one or more incorrectly selected or applied essential variable(s), a new test coupon may be fused with appropriate changes to the variable(s) that were determined to be the cause for test failure.
(c) When it is determined that the test failure was caused by one or more fusing conditions other than essential variables, a new set of test coupons may be fused with the appropriate changes to the fusing conditions that were determined to be the cause for test failure. If the new test passes, the fusing conditions that were determined to be the cause for the previous test failure shall be addressed by the organization to ensure that the required properties are achieved in all fused production joints.

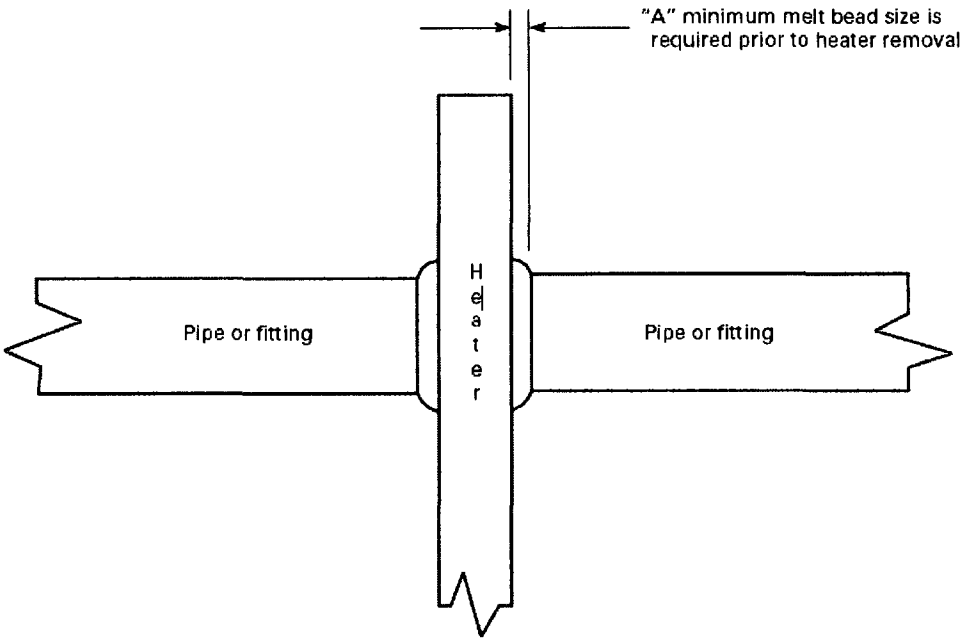
QF-203 Limits of Qualified Positions for Fusing Procedures
Unless otherwise specified by the fusing variables (QF-250), a procedure qualified in any position shown in Figure QF-461.2 qualifies for all positions. In addition, for the Plant Hatch Fusing Procedures, use of any fusing machine on a slope greater than 10 degrees requires testing in accordance with 2300 at the maximum slope to be used in production. (See 4321(c).)

QF-220 Production Fusing Procedure
QF-221 Plant Hatch Fusing Procedure
All fusing shall be performed in accordance with Plant Hatch FPS's, and limited to the following parameters. There shall be no deviation from these requirements.
(a) The pipe material is limited to PE 4710, cell classification 445574C, produced from DOW DGDA2492 bimodal polyethylene resin.
(b) The axis of the pipe is limited to the horizontal position ±45 deg. (See restriction in QF-203.)
(c) The pipe ends shall be faced to establish clean, parallel mating surfaces that are perpendicular to the pipe centerline on each pipe end, except for mitered joints. When the ends are brought together at the drag pressure, there shall be no visible gap.
(d) For mitered butt fusion joints, the pipe faces shall be at the specific angle to produce the mitered joint. When the ends are brought together at the drag pressure, there shall be no visible gap.
(e) The external surfaces of the pipe are aligned to within 10% of the pipe wall thickness.
(f) The drag pressure shall be measured and recorded. The theoretical fusing pressure shall be calculated so that an interfacial pressure of 60 psi to 90 psi is applied to the pipe ends. The butt-fusing gauge pressure set on the fusing machine shall be the theoretical fusing pressure plus drag pressure.

(g) The heater surface temperature shall be 400°F to 450°F.
(h) The initial heating shall begin by inserting the heater into the gap between the pipe ends and applying the butt fusing pressure until an indication of melt is observed around the circumference of the pipe. When observed, the pressure shall be reduced to drag pressure and the fixture shall be locked in position so that no outside force is applied to the joint during the heat soak cycle.
(i) The ends shall be held in place until the minimum bead size is formed between the heater faces and the pipe ends, as shown in Figure QF-221.1. For 14 NPS and larger pipe sizes, the minimum heat soak time of 4.5 min per inch of pipe wall thickness shall be obtained.
(j) After the proper bead size is formed, the machine shall be opened and the heater removed. The pipe end surfaces shall be smooth, flat, and free of contamination. The pipe ends shall be brought together and the butt-fusing pressure reapplied.
(k) The maximum time from separating the pipe ends from the heater until the pipe ends are pushed together shall not exceed the time given in Table QF-221.2.
(l) The butt-fusing pressure shall be maintained until the joint has cooled, after which the pipe may be removed from the joining machine. The minimum cool time at the butt-fusing pressure shall be 11 min per inch of pipe wall thickness of the thicker member, except that for ambient temperatures between 100°F and 125°F, the cool time shall be 13 min per inch of pipe wall thickness of the thicker member.

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Figure QF-221.1
Required Minimum Melt Bead Size



Pipe (O.D.), in. (mm)	"A" Minimum Melt Bead Size, in. (mm)
< 2.37 (60)	1/32 (1)
≥ 2.37 (60) to ≤ 3.5 (89)	1/16 (1.5)
> 3.5 (89) to ≤ 8.63 (219)	3/16 (5)
> 8.63 (219) to ≤ 12.75 (324)	1/4 (6)
> 12.75 (324) to ≤ 24 (610)	3/8 (10)
> 24 (610) to ≤ 36 (900)	7/16 (11)
> 36 (900) to ≤ 65 (1625)	9/16 (14)

Table QF-221.2
Maximum Heater Plate Removal Time for Pipe-to-Pipe Fusing

Pipe Wall Thickness, in. (mm)	Maximum Heater Plate Removal Time, sec
Field Applications	
0.17 to 0.36 (4 to 9)	8
> 0.36 to 0.55 (> 9 to 14)	10
> 0.55 to 1.18 (> 14 to 30)	15
> 1.18 to 2.5 (> 30 to 64)	20
> 2.5 to 4.5 (> 64 to 114)	25
> 4.5 (> 114)	30
Fabrication Shop	
1.18 to 2.5 (30 to 64)	40
> 2.5 to 4.5 (> 64 to 114)	50
> 4.5 (> 114)	60

QF-250 Fusing Variables

QF-251 Types of Fusing Variables for Fusing Procedure Specifications (FPS)

These variables (listed for each fusing process starting in Table QF-254) are categorized as essential or nonessential variables. The "Brief of Variables" listed in the tables are for reference only. See the complete variable description in QF-400.

QF-252 Essential Variables & Essential Parameters

Essential variables are those that will affect the mechanical properties of the fused joint, if changed, and require requalification of the FPS when any change exceeds the specified limits of the values recorded in the FPS for that variable. Essential parameters are additional parameters applicable to the Plant Hatch FPS which require re-testing in accordance with 2300 of the ATR when any change exceeds the specified values recorded in the FPS for that parameter (see Table QF-254).

QF-253 Non Essential Variables and Parameters

Nonessential variables and parameters are those that will not affect the mechanical properties of the fused joint, if changed, and do not require requalification of the FPS when changed.

Table QF-254
(a) Fusing Variables Procedure Specification
Polyethylene Pipe Butt Fusing

Paragraph		Brief of Parameter	Essential	Nonessential
Joints QF-402	.1	Ø Joint Type	x	
	.2	Ø Pipe surface alignment	x	
Material QF-403	.1	Ø PE See paragraph 2000, and below		
	.3	Ø Wall thickness See paragraph 2310(c), and below		
	.4	Ø Cross-sectional area		x
Position QF-404	.1	Ø Position See paragraph 4321(c), and below		
Thermal Conditions QF-405	.1	Ø Heater surface temperature	x	
	.2	Ø Interfacial pressure	x	
	.3	Decrease in melt bead width	x	
	.4	Increase in heater removal time	x	
	.5	Decrease in cool-down time	x	
Equipment QF-406	.1	Ø Fusing machine manufacturer See paragraph 2310(d), and below		
Technique QF-407	.1	Ø Shop to field or vice versa		x

(b) Fusing Parameters Procedure Specification
Polyethylene Pipe Butt Fusing

Paragraph	Brief of Parameter	Essential	Nonessential
2000	Change from DOW DGDA-2490/92	x	
2310(a)	Change in Piping Item product Form	x	
2310(b)	Change in Piping Item Manufacturer Facility	x	
2310(c)	Change in Combinations of Manufacturer Facilities	x	
2310(c)	Change in Diameter	x	
2310(c)	Change in Material Thickness	x	
2310(d)	Change in Fusing Carriage Make or Model	x	
4321(c)	Increase in Machine Slope to > 10 degrees	x	
4412(a)	Decrease in Ambient Temperature to < 50°F	x	
4412(b)	Increase in Ambient Temperature from 100°F-125°F		x
4412(b)	Increase in Ambient Temperature to > 125°F	x	

300 PERFORMANCE QUALIFICATIONS

QF-300 General

This Section lists the essential variables that apply to fusing machine operator performance qualifications. The fusing machine operator qualification is limited by the essential variables given for the fusing process. These variables are listed in Table QF-362.

QF-301 Tests

QF-301.1 Intent of Tests. The fusing machine operator performance qualification tests are intended to determine the ability of fusing machine operators to make sound fused joints when following a qualified FPS .

QF-301.2 Qualification Tests. Each organization shall qualify each fusing machine operator for the fusing process(es) to be used in production. The performance qualification tests shall be completed using a qualified FPS. A fusing machine operator qualified for fusing in accordance with one qualified FPS is also qualified for fusing in accordance with other qualified FPSs within the limits of the fusing operator essential performance variables given in Table QF-362. Visual and mechanical examination requirements are described in QF-302. Retests and renewal of qualification are given in QF-320.

QF-301.3 Identification of Fusing Machine Operators.
Each qualified fusing machine operator shall be assigned an identifying number, letter, or symbol by the organization, which shall be used to identify production fused joints completed by the fusing machine operator.

QF-301.4 Record of Tests. The record of fusing machine operator performance qualification (FPQ) tests shall include the qualified ranges of essential performance variables, the type of tests performed, and test results for each fusing machine operator.

QF-302 Type of Test Required
QF-302.1 Visual Examination. For pipe coupons, all surfaces shall be examined visually per QF-141 before cutting specimens. Pipe test coupons shall be visually examined per QF-141 over the entire circumference.

QF-302.2 Mechanical Tests. For pipe coupons, two bend test specimens shall be removed from the fused test joint at intervals of approximately 180 deg. Each specimen shall be tested by one of the following methods:
(a) Reverse-Bend Test. The specimens shall be removed as shown in Figure QF-463, illustration (a), and tested in accordance with QF-143.1.
(b) Guided Side-Bend Test. Each specimen shall be removed as shown in Figure QF-463, illustration (b), and prepared and tested in accordance with QF-143.2.

QF-303 Limits of Qualified Positions and Diameters (See QF-461)
QF-303.1 Pipe Positions. Fusing machine operators who pass the required tests for fusing in the test positions shown in Figures QF-461.1 and QF-461.2 shall be qualified for fusing within the following limits:
(a) The 5G test position qualifies for the horizontal position ±45 deg.
(b) Test positions other than 5G qualify for the orientation tested ±20 deg.

QF-303.2 Pipe Diameters. Pipe sizes within the ranges listed in Table QF-452.3 shall be used for test coupons to qualify within the ranges listed in Table QF-452.3.

QF-305 Fusing Machine Operators
Each fusing machine operator shall have passed the mechanical and visual examinations prescribed in QF-301 and QF-302.

QF-305.1 Testing. Qualification testing shall be performed on test coupons in accordance with QF-311 and the following requirements:
(a) The data required by QF-130 shall be recorded for each fusing machine operator.
(b) The supervisor conducting the test shall observe the making of the fused joint and verify that the FPS was followed.

QF-305.2 Examination. Test coupons fused in accordance with QF-305.1 shall be evaluated as follows:
(a) The completed joint shall be visually examined in accordance with QF-302.1.
(b) After the joint is complete, the data required by QF-130 shall be reviewed for compliance with the requirements of the FPS used for the qualification test.
(c) Bend test specimens shall be removed and tested and in accordance with QF-302.2.

QF-310 Qualification Test Coupons
QF-311 Test Coupons
The test coupons shall consist of fusing one pipe joint assembly in at least one of the positions shown in Figure QF-461.2.

QF-320 Retests and Renewal of Qualification
QF-321 Retests
A fusing machine operator who fails one or more of the tests prescribed in QF-302 during initial qualification, as applicable, may be retested under the following conditions.

QF-321.1 Immediate Retest Using Visual Examination. When the qualification coupon has failed the visual examination of QF-302.1, retests shall be accepted by visual examination before conducting the mechanical testing. When an immediate retest is made, the fusing machine operator shall make two consecutive test coupons. If both additional coupons pass the visual examination requirements, the examiner shall select one of the acceptable test coupons for specimen removal to facilitate conducting the required mechanical testing.

QF-321.2 Immediate Retest Using Mechanical Testing. When the qualification coupon has failed the mechanical testing of QF-302.2, and an immediate retest is conducted, the fusing machine operator shall make two consecutive test coupons. If both additional coupons pass the mechanical test requirements, the fusing machine operator is qualified.

QF-321.3 Further Training. When the fusing machine operator has undergone additional training or completed additional fusing practice joints, a new test shall be made for each fusion test joint that failed to meet the requirements.

QF-322 Expiration and Renewal of Qualification
QF-322.1 Expiration of Qualification. The performance qualification of a fusing machine operator shall be affected when one of the following conditions occurs:
(a) When a fusing machine operator has not completed a fused joint using a qualified FPS for a time period of 6 months or more, their qualification shall expire.

(b) When there is a specific reason to question the ability of the fusing machine operator to make fused joints meeting the requirements of this Section, the qualifications of the fusing machine operator shall be revoked.

QF-322.2 Renewal of Qualification

(a) Performance qualifications that have expired under the provisions of QF-322.1(a) may be renewed by having the fusing machine operator fuse a single test coupon and subjecting the test coupon to the testing required by QF-302. A successful test shall renew all of the fusing machine operator's previous qualifications. Failure of the test shall necessitate additional training and complete requalification per QF-301 through QF-310 for all positions, machines and diameter ranges to be used in production, without impact on previous fusing performed unless there is other reason to suspect their integrity.

(b) Fusing machine operators whose qualifications have been revoked under the provisions of QF-322.1(b) may be requalified by fusing a test coupon representative of the planned production work. The fused test coupon shall be tested as required by QF-302. A successful test shall restore the fusing machine operator's qualification within the qualified range of essential performance variables listed in Table QF-362. Failure of the test shall necessitate complete additional training and complete requalification per QF-301 through QF-310 for all positions, machines and diameters to be used in production, and any questionable previously fused joints shall be rejected and replaced.

QF-360 Essential Variables for Performance Qualification of Fusing Operators

QF-361 General

A fusing machine operator shall be requalified whenever a change is made in one or more of the essential variables listed in Table QF-362.

Table QF-362
Essential Variables Applicable to Fusing Machine Operators

Paragraph		Brief of Variables
QF-403 Material	.1	ϕ Pipe material
	.2	ϕ Pipe diameter
QF-404 Position	.1	+ Position
QF-406 Equipment	.1	ϕ Equipment manufacturer

400 FUSING DATA

QF-400 Variables

QF-401 General

Each fusing variable described in this Article is applicable for procedure qualification when referenced in QF-250 for each specific fusing process. Essential variables for performance qualification are referenced in QF-360 for each specific fusing process. A change from one fusing process to another fusing process requires requalification (e.g., a change from butt-fusing to electro-fusing).

QF-401.1 Essential Variable (Procedure). A fusing condition that, if changed, will affect the mechanical properties of the joint (e.g., a change in pipe wall thickness).

QF-401.1.1 Essential Parameters (Procedure). A fusing condition that, if changed, requires retesting in accordance with paragraph 2300.

QF-401.2 Essential Variable (Performance). A fusing condition that, if changed, will affect the ability of a fusing machine operator to make a sound fused joint [e.g., a change in pipe size (diameter) or pipe position].

QF-401.3 Nonessential Variable (Procedure). A fusing condition that, if changed, will not affect the mechanical properties of a fused joint [e.g., a change in pipe size (diameter)].

QF-403.3.1 Nonessential Parameter (Procedure). A fusing condition that, if changed, does not require retesting in accordance with paragraph 2300, but must be addressed in the FPS.

QF-401.4 Fusing Data. The fusing data includes the fusing variables grouped as joints, pipe material, position, thermal conditions, equipment, and technique.

QF-402 Joints
QF-402.1 A change in the type of joint from that qualified, except that a square butt joint qualifies a mitered joint.

QF-402.2 A change in the pipe O.D. surface misalignment of more than 10% of the wall thickness of the thinner member to be fused.

QF-403 Material
QF-403.1 A change to any pipe material other than DOW DGDA-2490/92 (reference paragraph 2000).

QF-403.2 A change in the pipe diameter beyond the range qualified in Table QF-452.3.

QF-403.3 A change in the pipe wall thickness (reference paragraph 2310(c))..

QF-403.4 A change in the cross-sectional area to be fused, ø.

QF-404 Position
QF-404.1 For performance, the addition of other fusing positions beyond that qualified. See QF-303.1. For procedures, a change in the slope of the fusing machine carriage to greater than 10 degrees from horizontal (reference paragraph 4321(c)).

QF-405 Thermal Conditions
QF-405.1 A change in the heater surface temperature to a value beyond the range specified in QF-221.

QF-405.2 A change in the interfacial pressure to a value beyond the range specified in QF-221.

QF-405.3 A decrease in melt bead size from that specified in QF-221.

QF-405.4 An increase in heater plate removal time from that specified in QF-221.

QF-405.5 A decrease in the cool time at butt-fusing pressure from that specified in QF-221.

QF-406 Equipment

QF-406.1 A change in the make or model of fusing machine carriage (reference paragraph 2310(d)).

QF-407 Technique

QF-407.1 A change in fabrication location from the fabrication shop to field applications or vice versa.

QF-420 Material Groupings

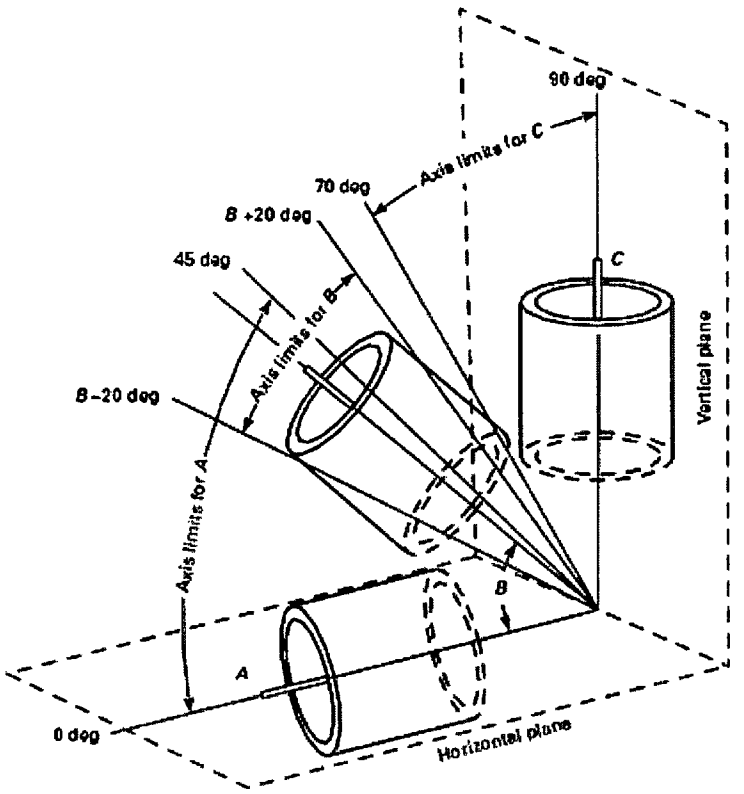
Not applicable to Plant Hatch

Table QF-452.3
Pipe Fusing Diameter Limits

Size of Test Coupon — IPS [in. (mm)]	Size Qualified — IPS [in. (mm)]	
	Minimum	Maximum
Less than 6 [6.625 (168)]	None	Size tested
6 to less than 8 [6.625 (168) to less than 8.625 (219)]	None	Less than 8 [less than 8.625 (219)]
8 to 20 [8.625 (219) to 20 (508)]	8 [8.625 (219)]	20 [20 (508)]
Greater than 20 [greater than 20 (508)]	Greater than 20 [greater than 20 (508)]	Unlimited

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Figure QF-461.1
Fusing Positions



Tabulation of Positions in Joints

Position	Diagram Reference	Inclination of Axis, deg
Horizontal	A	0 ± 45
Intermediate	B	B ± 20
Vertical	C	90 ± 20

GENERAL NOTE: Inclination of the axis is measured from the horizontal reference plane toward the vertical.

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Figure QF-461.2
Fusing Test Positions

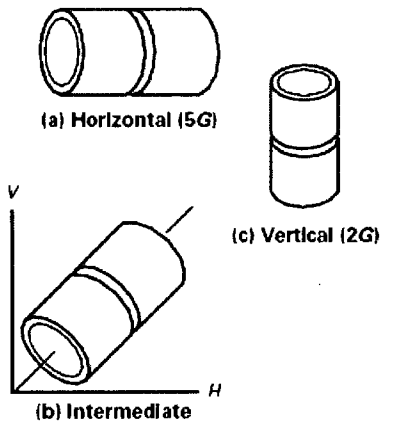
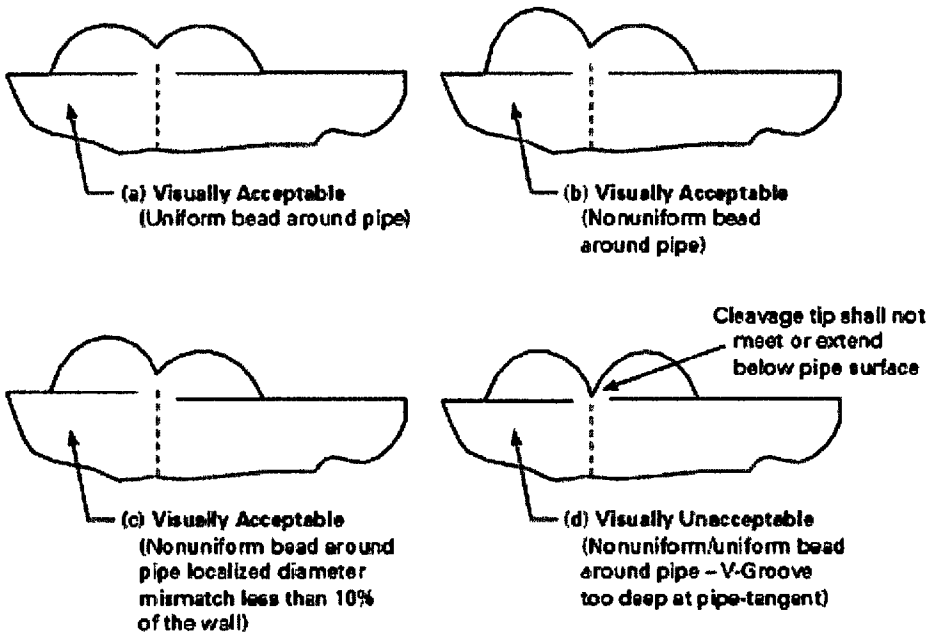
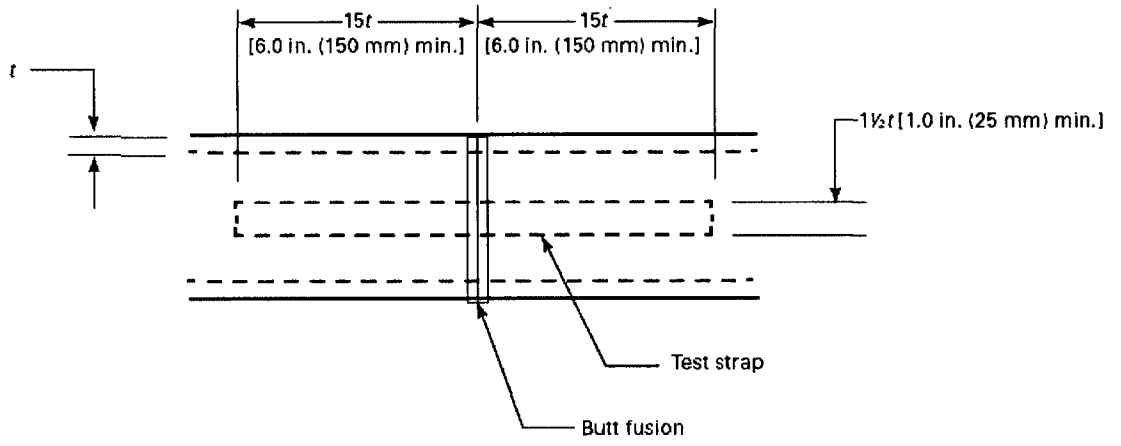


Figure QF-462
Cross Section of Upset Beads for Butt-Fused PE Pipe

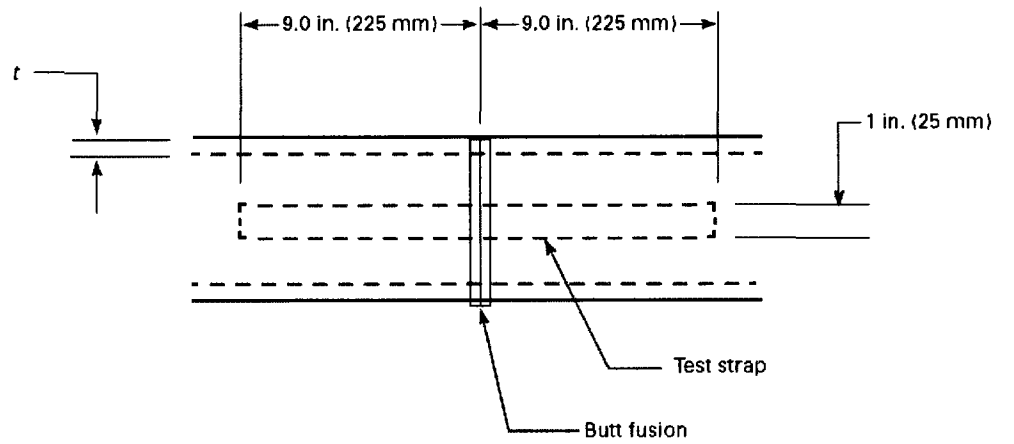


Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Figure QF-463
Bend Test Specimen Removal, Configuration, and Testing

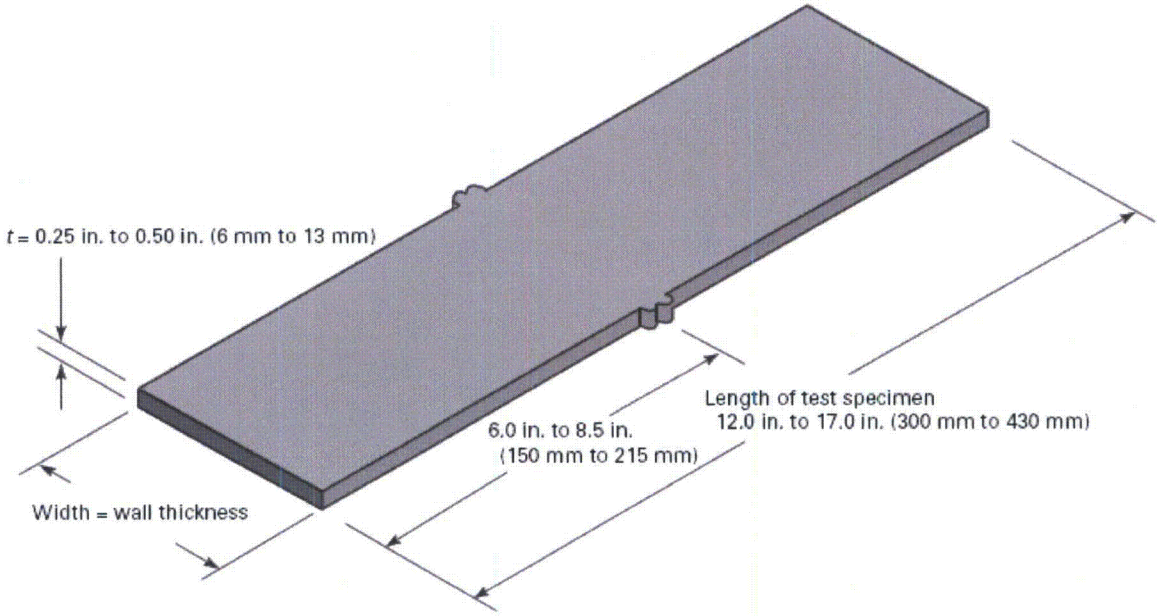


(a) Reverse-Bend Test Specimen Removal [for $t_{max} \leq 1$ in. (25 mm)]

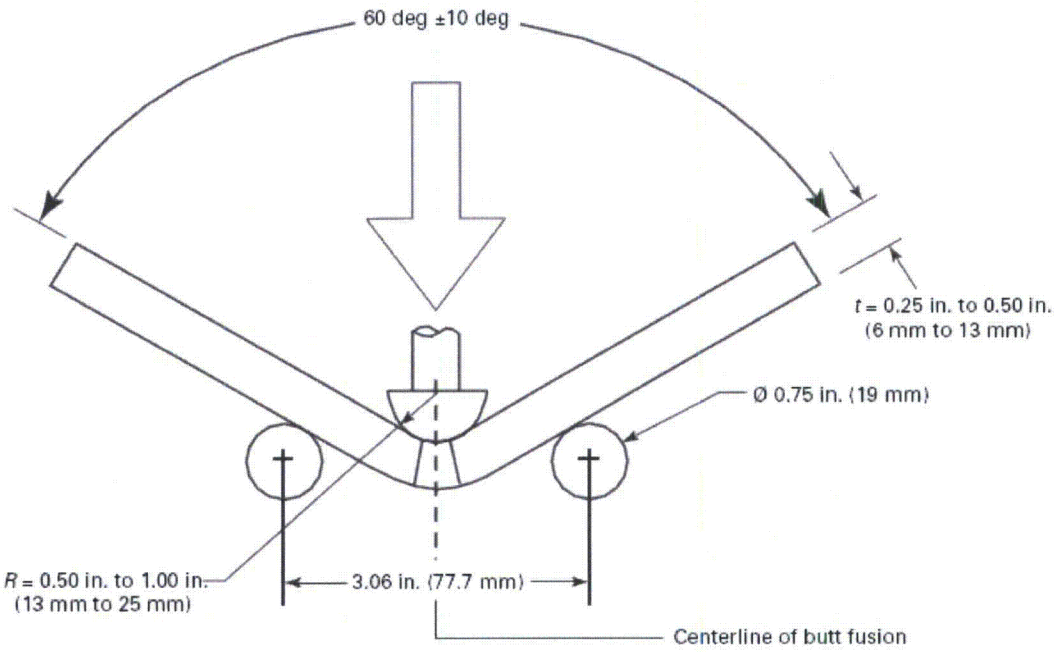


(b) Guided Side-Bend Test Specimen Removal [for $t_{max} > 1$ in. (25 mm)]

Figure QF-463
Bend Test Specimen Removal, Configuration, and Testing (Cont'd)



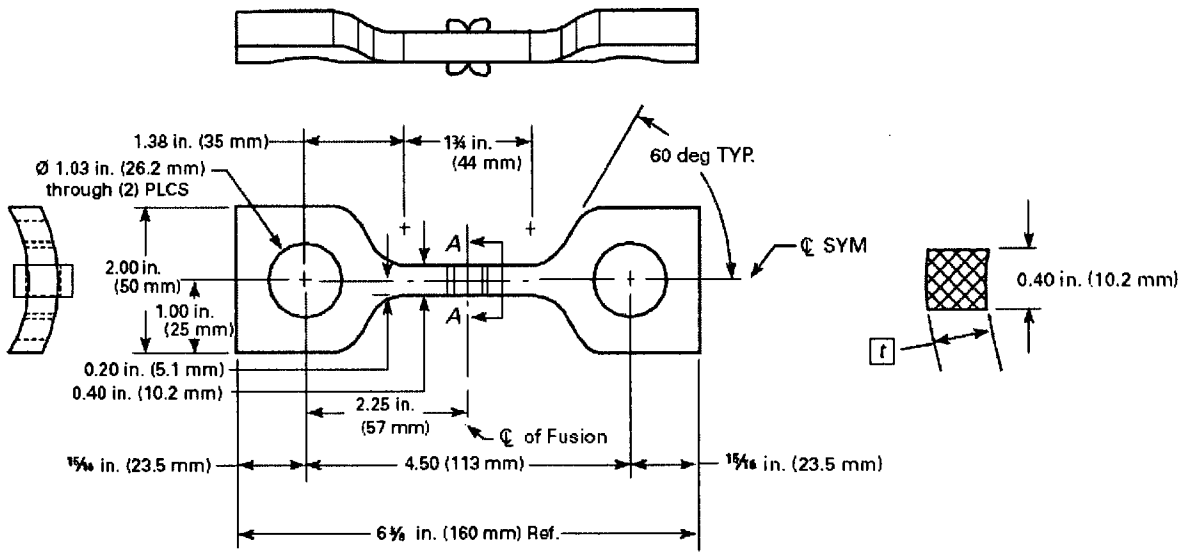
(c) Guided Side-Bend Test Specimen



(d) Guided Side-Bend Test Machine Dimensions

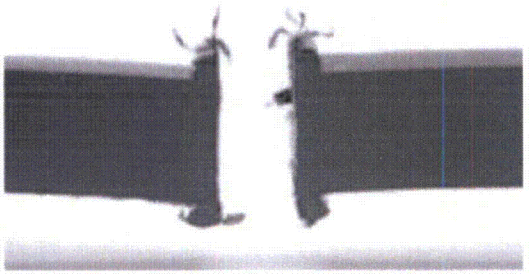
Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Figure QF-464
HSTIT Specimen Configuration and Dimensions

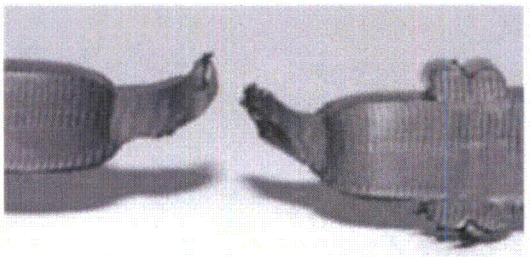


GENERAL NOTES:
(a) All machined surfaces 125 RMS or better.
(b) 3 place dimensions ±0.005 in. (±0.13 mm).
(c) 2 place dimensions ±0.010 in. (±0.25 mm).
(d) Fractional dimensions ±1/32 in. (±0.80 mm).
(e) All internal radii R1/2 in. (±0.13 mm).
(f) All external radii R3/8 in. (10 mm).
(g) Bead remains on after machining.

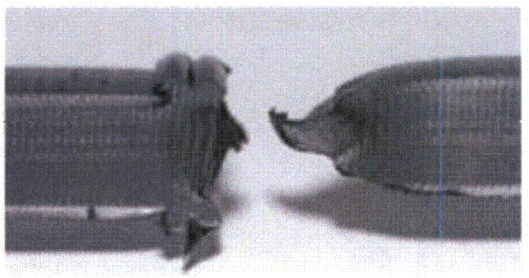
Figure QF-465
HSTIT Specimen Failure Examples



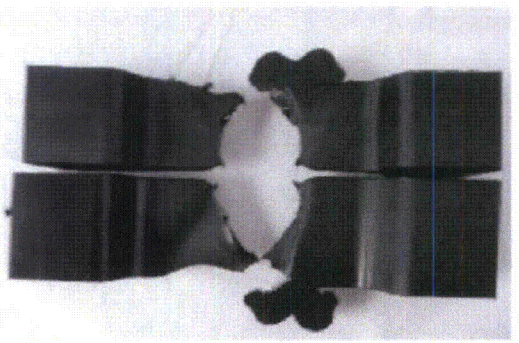
(a) Brittle Rupture



(b) Ductile Rupture Outside Fusion Interface



(c) Ductile Rupture Adjacent to Fusion Interface



(d) Ductile Ruptures of Split Specimens

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Supplement 4 Code Data Report Form

FORM NM(PE)-1 DATA REPORT FOR NONMETALLIC BATCH PRODUCED PRODUCTS REQUIRING FUSING

As Required by the Provisions of the ASME Section XI, Code and the Hatch Alternative Technical Requirements (ATR) of HNP-ISI-ALT-HDPE-01

1. Manufactured by _____
(name and address of Manufacturer of nonmetallic products)

2. Manufactured for _____
(name and address of purchaser)

3. (a) Product Identification _____
(Lot No., Batch No., etc.) (Print String)

(b) Owner _____

4. Manufactured according to Material Spec. _____ **Purchase Order No.** _____
(ASTM)

5. Remarks _____
(brief description of fabrication)

_____

_____

Certificate of Compliance

We certify that the statements made in this report are correct and that the products defined in this report conform to the requirements of the ASME Material specification listed above on line 4. The Certified Material Batch Reports provided for the material covered by this report.

Certificate of Authorization (n/a if Owner) No. _____ to use the _____ Symbol
Certificate of Authorization expires _____
(Date)

Date _____ Name _____ Signed _____
(Certificate Holder) (Authorized Signature)

Certificate of Inspection

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by _____ of _____ have inspected the products described in this Partial Data Report for product in accordance with the ASME Section XI, Division 1 or 2, Code and the Hatch Alternative Technical Requirements (ATR) of HNP-ISI-ALT-HDPE-01. By signing this certificate neither the inspector nor his employer makes any warranty, expressed or implied, concerning the products described in this Partial Data Report. Furthermore, neither the inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ Signed _____ Commission _____
(Authorized Nuclear Inservice Inspector) (Nat. Board No. and Endorsement)

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Supplement 5 – Section XI Inservice Inspection

General

This supplement defines the Section XI Inservice Inspection requirements applicable to the installed Class 3 HDPE piping.

Periodic Pressure Test

For all piping installed under this ATR, a pressure decay test shall be performed at least once per ISI Inspection Interval to verify maintenance of structural integrity throughout the design life of the system. Successful tests will also reaffirm: 1) absence of detrimental slow crack growth, 2) absence of detrimental cold fusion in joints, and 3) adequacy of design modulus of elasticity based on time in service, temperature and operating stresses. This testing shall be performed as follows:

a) The HDPE Piping shall be physically isolated from the remainder of the system so as to eliminate the possibility of leak-by through adjacent valves.

b) The isolated portion of the system shall be pressurized to the maximum normal operating pressure using the controlled means described in 6223(a) of this ATR. Hold time at test pressure during make-up water injection may be reduced if stabilization occurs prior to 4 hours.

> 1) Test pressure (maximum normal operating pressure) shall equal or exceed the maximum pressure recorded for that portion of the system since the previous inservice inspection (or construction preservice inspection) pressure test.

c) After the system pressure stabilizes, the injection of make-up water shall be terminated, and the HDPE portion of the system shall be isolated from the test pump.

d) The system pressure shall then be monitored for one hour.

Acceptance Criteria

During the monitoring period, there shall be no reduction in pressure greater than 5% of the test pressure that is not accounted for by temperature change.

Nonmandatory Supplement A
FUSING MACHINE OPERATOR QUALIFICATION TRAINING

A-100 SCOPE

(a) The major portion of the quality of polyethylene piping is determined by the skills of the fusing machine operators. When installing polyethylene piping, the quality of the fusion joints is essential for the piping system.

(b) It is important that the fusing machine operators are trained and competent in the fusing technology employed in constructing polyethylene piping systems. Continued competence of the fusing operator is covered by periodic retraining and reassessment.

(c) This document gives guidance for the training, assessment and approval of fusing operators to establish and maintain competency in construction of polyethylene piping for pressure applications. The fusion joining technique covered by this Appendix is thermal butt fusion. This Appendix covers both the theoretical and practical knowledge necessary to ensure high quality fusion joints.

A-110 REFERENCES

The fusion standards in this Appendix are listed Table A-110-1.

A-200 TRAINING

A-210 TRAINING COURSE

(a) The course should cover all aspects of the butt fusion process including safety, machine evaluation and maintenance, machine operation, FPS guidelines, pressure and temperature setting, data log device operation and set-up, in-ditch fusing techniques, visual examination guidance, and data log record evaluation. The minimum course duration is 24 hr.

(b) The course will be delivered by a competent qualified trainer with a minimum of 3 yr of experience in the butt fusion processes and who has mastered the techniques involved.

(c) The trainer should have a range of fusing machines representative of the equipment encountered on worksites for installing pipes, in order for the trainee fusing operator to become acquainted with the fusing equipment commonly used. The trainee fusing operator may be trained on one of these fusing machines or on a machine from his own company if accepted by the training center. The fusing equipment must comply with the fusing machine manufacturer's specifications or ISO 12176-1, see Table A-110-1.

A-220 OPERATOR ASSESSMENT

The trainee fusing operator who has followed a training course as described above should then pass a theoretical and practical assessment in order to be qualified as a fusing operator for polyethylene systems. The assessor should not be the trainer but should have the same assessment qualifications as the trainer shown above.

A-230 TRAINING CURRICULUM

(a) The training course should be comprised of any combination of fusing packages based on the requirements of utility or pipeline operators. These packages may be given as individual modules or combined to suit requirements. The course shall include safety training related to the fusing process and equipment.

(b) All consumables and tools necessary for the training package should be available during the training session. The pipes and fittings to be used shall conform to the ASTM product forms permitted by this Appendix.

(c) The lessons should be designed so that the trainee fusing operator learns to master the fusing technique and attains a good working knowledge of the piping system materials and practical problems encountered when fusing pipe in the field. The fusing operator should receive a written manual covering all the elements dealt with in the training.

Table A-110-1
Fusion Standards and Specifications Referenced in Text

Standard	Subject	Edition
ASTM F2620	Heat Fusion Joining of PE Pipe & Fittings (for reference only)	2009
ISO 12176-1	Plastic Pipe & Fittings – Equipment for Fusion Joining	2006
ISO TR 19480	Guidance for Training and Assessment of Fusion Operators	2005
PPI TR-33	Generic Butt Fusion Procedure (for reference only)	2012

(d) The theoretical course should deal with general information in connection with raw materials, pipes and fittings, and also with theoretical knowledge about preparation, tools and devices, joining components, different materials, different diameter ratios, and correct and incorrect parameters. The safety course should include information concerning the fusing process, such as protective clothing, general safety, regulations for electrical equipment, handling heater plates, etc. Areas of study should include but not be limited to the following:

(1) Butt fusion joining.

(a) Principles of fusion.

(b) Straight/coiled pipes, service lines, main lines, etc.

(c) Components: pipes, flange adapters, saddle fittings, other fittings.

(d) Butt fusing equipment: manual, semiautomatic and automatic machines.

(e) Joint preparation: cleaning, rounding, alignment, facing, etc.

(f) Butt fusion cycle: diagram showing pressure, time and temperature relationships.

(g) Failure modes: understanding and avoiding possible mistakes.

(h) Test methods: visual examination, high-speed tensile-impact test, bending test, hydrostatic test, data log recording/evaluation, etc.

(2) The trainee fusing operator should be familiar with the butt fusion joining technique and procedure (FPS) by making a sufficient number of butt fusion joints. In some cases, the fusing technique may vary slightly according to diameter, material or other factors. In such cases, the trainee fusing operator should also be made familiar with the various techniques.

(3) The trainee should start by making a butt joint between two pipes, and should then learn to make butt fusion joints with pipes and fittings such as tees, reducers, etc.

(4) The trainee should learn how to detect and avoid typical fusion defects.

(5) The trainee should learn how to assess the quality of a butt fusion joint by doing a visual examination of the butt fusion joint and comparing it to the visual guidelines published in the pipe manufacturer's heat fusion joining procedure booklet. The trainee should also compare the data log record to the FPS to ensure the proper parameters and procedures were followed in the butt fusion process.

A-300 ASSESSMENT AND TESTING

(a) Training program should end with a theoretical and practical examination (test piece).

(b) The content of the theoretical examination shall consist of not less than 20 multiple choice questions about the butt fusion process, fusing machine operation, pipe, quality examination, safety, etc. within a set period of time. A score of 80% or better is considered passing on this examination. Questions to be included but not limited to are:

- How do you calculate the fusing machine gage pressure?
- What is the proper heater surface temperature range from the FPS?
- What is the proper butt fusion interfacial pressure range from the FPS?
- How do you calculate the drag pressure?
- How do you know when to remove the heater in the heating cycle?
- How long do you leave the pipe ends together under pressure in the cooling cycle?
- What is the difference between IPS pipe and DIPS pipe?
- How do I determine the hydraulic fusing machines total effective piston area?
- How is the total effective piston area of the fusing machine used to determine the fusing machines gage pressure for a specific pipe?
- How do you adjust the machine to improve the alignment of the pipe after facing?
- How much material should be removed from the pipe ends in the facing operation?
- How do you determine if the fusing machine conforms to the equipment manufacturer's specifications?
- How do you align the pipe in the butt fusing machine?
- Can you butt fuse pipe in a ditch?
- What is interfacial pressure?

(c) The practical examination will require the trainee fusing operator to make a fusion joint with a hydraulic butt fusing machine with a minimum pipe size of IPS 8 DR 11. A data acquisition device must be attached to the fusing machine and the data concerning the joint entered. The data log device shall be used to record the joint made by the trainee. The assessor shall observe the butt fusion joint and note if the proper procedure (FPS) was followed. After the joint is complete, the data log record shall be reviewed by the assessor and compared to the FPS to ensure the proper procedures were followed. The assessor will then conduct a visual examination of the joint to make sure it satisfies the visual acceptance criteria per Fig. 5321-1.

(d) Trainees who pass the theoretical and practical examination shall be documented on a training record. The record should state the technique or techniques and fusing machines that were used. If the fused specimens are used for fusing operator qualification, they shall be tested in accordance with 4300.

A-400 REASSESSMENT

If the trainee fails one of the examinations, he should retake it after a period not shorter than one week. If the trainee fails the examination for the second time, the trainee should repeat the training course before taking the test again.

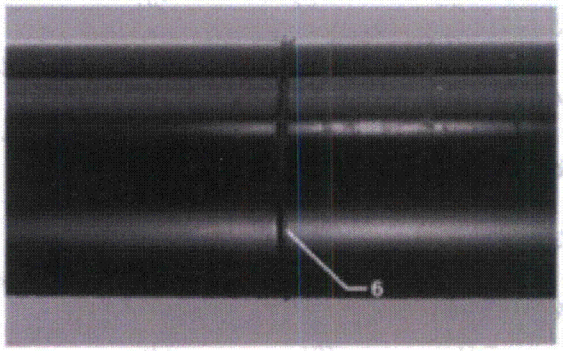
If the trainee fails fusing operator qualification testing, retesting shall be performed as permitted by Supplement 3.

Proposed Alternative Technical Requirements to ASME Section XI Requirements for Replacement of Class 3 Buried Piping in Accordance with 10 CFR 50.55a(a)(3)(i)

Nonmandatory Supplement B

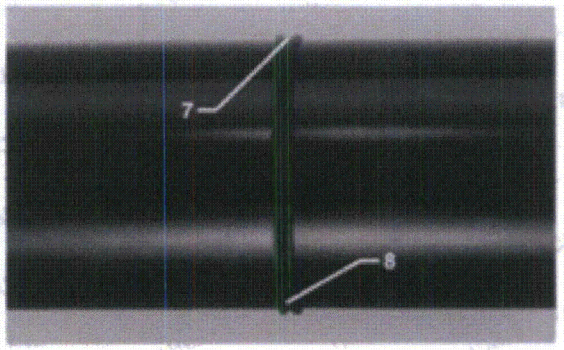
Fig. B-1 Unacceptable Fusion Bead Configurations

Butt Fusion of Pipe
Unacceptable Appearance – Insufficient Melt



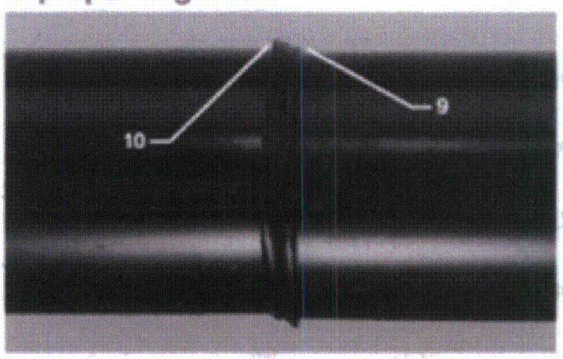
6. Melt Bead Too Small For 2-Inch And Larger Mains

Butt Fusion of Pipe
Unacceptable Appearance – Inadequate Roll Back



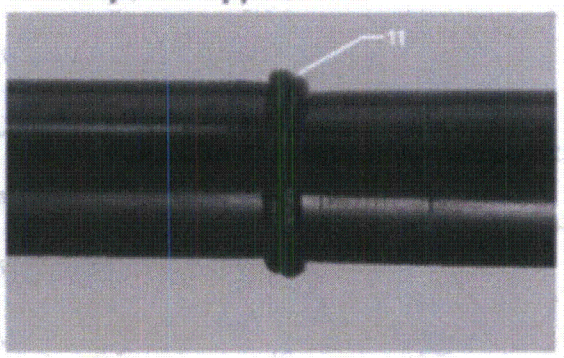
7. Insufficient Fusion Pressure – "V" Shaped Melt Appearance
8. Inadequate Roll Back of Bead

Butt Fusion of Pipe
Unacceptable Appearance – Improper Alignment



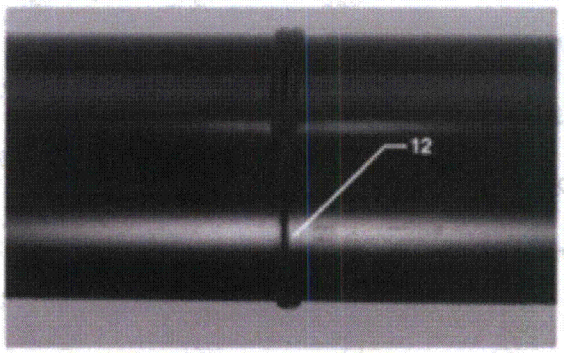
9. "High-Low" Condition 10. Inadequate Roll Back Of Bead Due To Improper Alignment

Butt Fusion of Pipe
Unacceptable Appearance



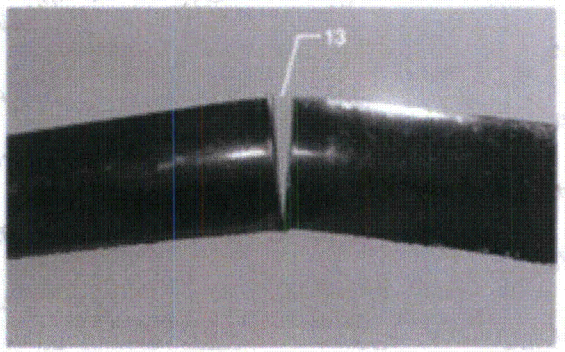
11. Excessive Melt, Improper Alignment And/Or Excessive Pressure

Butt Fusion of Pipe
Unacceptable Appearance – Incomplete Face Off



12. No Melt Bead Caused By Incomplete Face Off

Butt Fusion of Pipe
Unacceptable Appearance – Incomplete Face Off



13. Unbonded Area In Joint Of Cut Strap

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Proposed Inservice Inspection Alternative HNP-ISI-ALT-HDPE-01, Version 1.0

Enclosure 3

Sketch of Proposed HDPE Piping Tie-ins and Conceptual Routing

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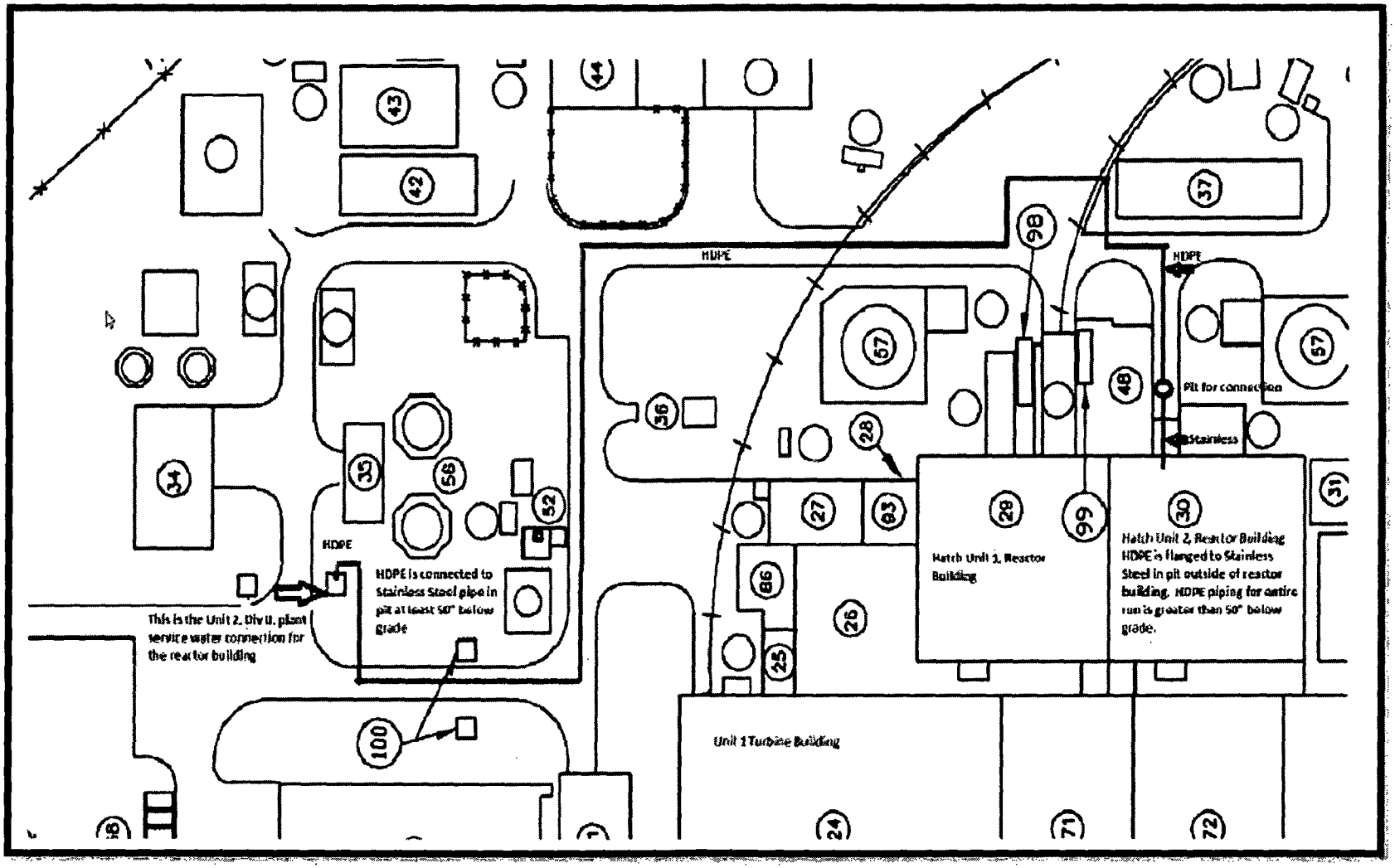
Enclosure 3

Sketch of Proposed HDPE Piping tie-ins and conceptual routing



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Enclosure 4

Summary of the Plant Hatch HDPE ISI Alternative
with the NRC Expectations described in ADAMS Document No. ML13318A046

Summary of the Plant Hatch HDPE ISI Alternative
with the NRC Expectations described in ADAMS Document No. ML13318A046

Note: References in parentheses identify the sections of the Alternative Technical Requirements that describe the requirements. Footnote references at the conclusion of each statement identify the slide number of ADAMS document ML13318A046 identifying NRC expectations.

Licensee proposed alternative to ASME Code IWA-4000 under 10 CFR 50.55a(a)(3)(i)

- Previous similar alternative: Callaway Relief Request, approved November 7, 2008 (ML083100288):
  - Some destructive exams; volumetric NDE of welds.[25][27]

- Plant Hatch's alternative is similar to Callaway's in that it is plant and segment-of-system specific, except that the Hatch alternative is considered a permanent request. Follow-on inspection or testing will be performed as follows:

  > Provisions will be included for performing by the end of each 10-year inspection interval, an isolated pressure drop test at maximum operating pressure of the entire HDPE piping run. The purpose of the test is to confirm maintenance of pressure integrity over time (Supplement 5).[26][27]

- The Plant Hatch Alternative demonstrates adequate structural design, using the same design methodology as Callaway, with a few enhancements due to evolution of HDPE design over the course of five years. The design considers all normal and safety functions of the piping system (3000).[28]

- The Plant Hatch alternative addresses potential day-to-day variability of material properties of resin and pipe from a given supplier by either 1) requiring the material supplier to have and maintain an Appendix B QA Program, audited and approved by SNC, or 2) SNC performing any Quality Program functions (including inspections and tests) that would normally be the responsibility of the Polyethylene Material Organization, and describing the functions performed by SNC in the Plant Hatch QA Program (similar to the Callaway approach). In addition, the Plant Hatch alternative specifies use of Dow Chemical, DGDA-2492 resin (the same resin used at Callaway) and requires all products for this project to be produced the same batch of resin (1200, 2000).[29]

- Every combination of resin, Material Supplier and facility, pipe size, thickness, fusing machine carriage make and model shall be tested prior to production fusing. One joint shall be made at each of the following extremes of the fusing procedure: (a) Maximum interfacial pressure of 90 psi and maximum heater temperature of 450°F, with heater removal (dwell time) kept to a minimum, not to exceed the specified maximum; (b) Maximum interfacial pressure of 90 psi and minimum heater temperature of 400°F, with heater removal (dwell time) at the maximum permitted; (c) Minimum interfacial pressure of 60 psi and maximum heater temperature of 450°F, with heater removal (dwell time) kept to a minimum, not to exceed specified maximum; (d) Minimum interfacial pressure of 60 psi and minimum heater temperature of 400°F, with heater removal (dwell

time) at the maximum permitted. Not less than four (4) specimens shall be removed from each test joint and tested using the High Speed Tensile Impact Test (2300).[30]

- To address lack of NDE to identify cold fusion, the Plant Hatch Alternative requires a hydrostatic test of 1.5 times system design pressure upon completion of installation and prior to burial of fused joints. The pressure drop portion of this test (one hour isolated with no more than 5% reduction in pressure) will serve as the preservice inspection for the planned inservice pressure testing described above (6220).[31]

- Within each ten (10) year ISI inspection interval, the installed HDPE portion of the system will be isolated from the adjacent piping, and an isolated pressure drop test will be required at maximum operating pressure of the entire HDPE piping run. The purpose of the test is to confirm maintenance of pressure integrity over time. Successful tests will verify: 1) absence of detrimental slow crack growth, 2) absence of detrimental cold fusion in joints, and 3) adequacy of design modulus of elasticity based on time in service, temperature and operating stresses (Supplement 5 of the ATR).[32]

- With respect to acceptable design criteria, the design of the new HDPE piping will address potential temperature excursions for this raw water inlet piping using the minimum and maximum credible temperatures for of the source of supply. The design will utilize a design factor (DF) of 0.50. This project does not involve HDPE piping of a thickness where thermal gradients would be of concern (Table 3131-1).[33]

- As this project is modeled after the Callaway approach, included is destructive testing of fused samples for every combination of resin, Material Supplier and facility, pipe size, thickness, fusing machine carriage make and model prior to performance of production fusing. Lack of supplier QA program and resultant potential day-to-day variability of material properties is addressed above by requiring either an approved 10CFR50 Appendix B approved QA program applicable to material supply, or by SNC providing quality functions and oversight at the suppliers' facilities. Lack of NDE which can detect cold fusion is addressed above, by requiring a hydrotest at 1.5 times design pressure upon completion of installation and prior to burial of the fused joints (1200, 2300, 6220).[35]

- The Plant Hatch Alternative includes 100% ultrasonic examination of all fused joints, including mitered joints, using the phased array ultrasonic (UT) technique developed by ASME Code committees for HDPE. The extent of examination and sensitivity of the process exceed those applied on the Callaway project that utilized TOFD ultrasonic inspection, and which is not suitable for examination of mitered joints. Using the phased array UT provides further assurance of quality and consistency in material variability. Although no UT technique has to-date demonstrated ability to detect cold fusion, the probability of any cold fusion remaining undetected in any fused joint is

significantly minimized by performance the final hydrotest at 1.5 times design pressure (5220, 6220).[36]

- The Plant Hatch Alternative requires the ultrasonic examination procedure to be performance demonstrated on the same HDPE material including a fused joints representative of the joints to be examined. The demonstration specimens shall include both planar and volumetric fabrication-type flaws representative of the fusing process used in production. The specimens shall include flaws classified as surface flaws – both surface-connected and embedded, as well as embedded subsurface flaws meeting IWA-3000 requirements. There shall be at least 15 flaws in the demonstration set consisting in size from 0.040 in. or 10% of the section thickness to 90% of the section thickness. The demonstration requires that 100% of detectable relevant flaws be identified, with no more than 20% false calls. Embedment of flaws in the specimens will consider potential for impact on structural integrity, potential precursors to slow crack growth, and long-term impact on ten-year ISI pressure testing (5115).[37]

- Acceptance criteria for volumetric examination requires that any indication of a flaw not attributable to configuration within the examination volume shall cause rejection of the fused joint. This is similar to the zero identifiable defects criteria that was applied on the Callaway project. Repair of such joints is not permitted (5330).[38]

Edwin I. Hatch Nuclear Plant – Unit 2
Proposed Inservice Inspection Alternative HNP-ISI-ALT-HDPE-01, Version 1.0

Enclosure 5

Technical Information for Dow Chemical resin,
DGDA-2492

Technical Information

CONTINUUM™ DGDA-2492N NT
Bimodal Polyethylene Resin

Overview

CONTINUUM™ DGDA-2492N NT Bimodal Polyethylene Resin is produced using UNIPOL™ II process technology. This product may be utilized for pipe applications where long-term hydrostatic strength combined with outstanding resistance to slow crack growth, rapid crack propagation, and high melt strength is desired. Suitable applications include water pipes at nuclear power facilities, natural gas distribution pipes, large diameter industrial piping, mining, sewage, and municipal water service lines.

Industrial Standards Compliance:
ASTM D 3350: cell classification
- Natural - PE445574A
- Black - PE445574C (See NOTES)

Plastics Pipe Institute (PPI): TR-4:
- Black Pipe - CONTINUUM™ DGDA-2492N BK
  - ASTM PE4710 pipe grade - 1600psi HDB and 1000psi HDS @ 73°F, and 1000psi HDB @ 140°F

National Sanitation Foundation (NSF): Standard 14 and 61
- Black PE4710 Pipe - CONTINUUM DGDA-2492

Consult the regulations for complete details.

NOTES: Natural resin extruded under proper conditions with carbon black masterbatch DFNF-0092 (2.5%).

Physical	Nominal Value (English)	Nominal Value (SI)	Test Method
Density			
--	0.949 g/cm³	0.949 g/cm³	ASTM D1505 [1]
--	0.959 g/cm³	0.959 g/cm³	ASTM D1505 [2]
Melt Index			ASTM D1238
190°C/2.16 kg	0.060 g/10 min	0.060 g/10 min	
190°C/21.6 kg	5.5 g/10 min	5.5 g/10 min	
Mechanical	**Nominal Value (English)**	**Nominal Value (SI)**	**Test Method**
Tensile Strength (Yield)	3600 psi	24.8 MPa	ASTM D638 [3]
Tensile Elongation (Break)	740 %	740 %	ASTM D638 [3]
Flexural Modulus	150000 psi	1030 MPa	ASTM D790B [4,3]
Resistance to Rapid Crack Propagation, Pc			
Full Scale: 32°F (0°C)	> 665 psi	> 45.9 bar	ISO 13478 [5]
S-4: 32°F (0°C)	> 174 psi	> 12.0 bar	ISO 13477 [6]
Resistance to Rapid Crack Propagation, Tc - S-4	< 0.00 °F	< 0.00 °F	ISO 13477 [7]
Slow Crack Growth PENT	> 10000 hr	> 10000 hr	ASTM F1473 [3]
Impact	**Nominal Value (English)**	**Nominal Value (SI)**	**Test Method**
Notched Izod Impact (73°F (23°C))	9.1 ft-lb/in	490 J/m	ASTM D256A [3]
Thermal	**Nominal Value (English)**	**Nominal Value (SI)**	**Test Method**
Brittleness Temperature	< -103 °F	< -75.0 °C	ASTM D746A [3]
Thermal Stability	> 428 °F	> 220 °C	ASTM D3350

Extrusion	Nominal Value (English)	Nominal Value (SI)
Melt Temperature	380 to 440 °F	193 to 227 °C

Extrusion Notes

Fabrication Conditions:
- Screw Type: High quality HDPE (preferably barrier for complete melting)
- Melt Temperature Range: 380-440°F (193-225°C)

Form No. 400-00143240en
Rev. 2010-07-28